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FOREST DEVASTATION IN MICHIGAN

A STUDY OF SOME OF ITS DELETERIOUS ECONOMIC EFFECTS

BY RUSSELL WATSON

Assistant Professor of Forestry, University of Michigan

"They say the Lion and the Lizard keep
The Courts where Jamshyd gloried, and drank deep."

Forest Devastation is used in this paper with the meaning as given in Webster: *"Devastate,* to lay waste; to ravage; desolate. Synonyms: Waste, demolish, plunder, pillage." To devastate a forest is, then, to rob or plunder the forest property, or to waste it. The idea of destruction, as in the cutting and the burning of a forest is not the only idea in the term devastation, it is also to waste, akin to squander.

A forest is a property growing crops of timber. The term forest implies soil, climate, and growing stock, all in condition for growth of timber. If the forest is devastated, or laid waste, it means that conditions of growth are changed seriously, and the amount of growth is seriously diminished. For purposes of definition, it can be said that if the forest is so injured that its growth is reduced in volume fifty per cent or more, it has been devastated.

This paper is an inquiry into a few of the economic and social results of forest devastation. The fundamental causes of forest devastation are, in the main, merely mistakes of judgment in the handling of natural resources; they are human errors generally made unwittingly. There may be, perhaps, in this story of the effects of devastation within one small area, together with similar accounts for other forest regions, sufficient evidence to give good cause for legal prohibition of further wasting.

To a degree that the public ordinarily does not realize within the present century this country will need every acre of productive land to supply itself with the essentials of food, clothing, and habitation. Nor can we in the future, despite remarkable advances in rapidity and ease of transportation, look to new countries for the essentials of living, for they too have been, are being, and doubtless will continue to be, as wrongfully exploited as our own.

The people of the world have been on a land debauch during the past centuries. This debauch has continued on an unprecedented scale during the past hundred years. Man has developed and has greedily accepted every new device which would more rapidly enrich the present without regard for the future. The steam skidder and the methods of high lead logging are forest destroyers whose extraordinary destructiveness the forester cannot hope to overcome. He has but the slow forces of nature to work with. Such instruments are Frankensteins which bid fair to overcome us. They are Juggernauts which, let loose upon the forest, are ruthlessly crushing and destroying our essential resources. In our eagerness to open up the country, to develop the land, to get "cheap logs," we have worked ourselves into an hysteria and a feverish, thoughtless activity which is blind alike to the hideous results of past actions and to the certainties of evil future consequences. We have hastened recklessly on, heeding not the warnings of Malthus; we have sat gaily at the feast, nor thought of the famine of the morrow. Economic development of our natural resources has been, and is, synonymous with destruction.

Such a devastated region as is described here cannot again become productive without the combined efforts of county, State, and Nation in consistently following a well thought-out land policy. With few exceptions, the counties affected are incapable of much self help. Their impoverishment resulted in the enrichment, even though but temporarily, of other parts of the State and Nation. It was largely, too, through laws passed by the State legislature and Congress, that the region was allowed to become devastated. It is from the State and Nation then, that the major part of the burden of the rehabilitation must come.

The primary duty of government is to administer its territory in such a way as to make it a permanent home of comfort and well-being for its people. A decent regard for the present inhabitants and posterity of the State and Nation require that we look to the reconstruction

along sound economic lines of our devastated regions with a solemn resolve that once reconstructed at the expense of all, they shall not again be devastated.

SUMMARY OF CONCLUSIONS

The region has been subjected to a heedless, intense exploitation and devastation. Its resources have been removed and destroyed. The greatest resource, the forest, has been almost totally destroyed and the soil tremendously damaged by forest fires. No pine forests remain; but few acres of swamp forest are intact and the bulk of the remaining hardwoods will be cut in less than ten years. There is no apparent disposition on the part of the exploiters to conduct their operations in the remaining forests differently from their methods of the past. Forest destruction has resulted in decadence of the region; and this decadence is becoming progressively more serious, with no relief from any source in sight. Hundreds of miles of railroad are already abandoned, and more is being abandoned yearly. Population, both rural and urban, and of all classes, is becoming less. Value of taxable property is declining, and tax rates are rising. Many counties are in debt to the State for taxes, and the acreage of land forfeited on account of delinquency of taxes is assuming alarming proportions. Each tax equalization shows a smaller share of the burdens of the State carried by the region. Many communities have nearly disappeared and many townships have been abandoned as civic units. Invested capital is being withdrawn and the earnings of the lumber industry are being put to work in other States. The rate of increase of farmed areas has slowed up, the numbers of farms and of farmers, have declined, and maintenance of the soil productivity is causing serious concern.

Broadly, the present economic situation in northern Michigan is based upon the liquidation of its resources. The land, however, remains, and must ever remain, either productive or a liability to the State.

The profits of exploitation have not gone for the most part to the present citizens and communities, nor have they, excepting in small part, been returned to the land. Not alone has the land been exploited to its extreme detriment, but also, in the final analysis, a similar impoverishment of condition and opportunity has resulted to the farmer, the laborer, the tradesman, and the professional class.

The available resources of the area are diminishing much more rapidly than the population is decreasing. This is to be expected, for people

cling to their homes in the face of adversity. The result is that incomes are decreasing yearly and standards of living are on the decline. This is certain to become more serious in the future.[1]

THE REGION STUDIED

Location

The study here recorded covers that part of the southern peninsula of Michigan which lies north of a line drawn from Saginaw Bay on Lake Huron to the mouth of the Marquette River, at Ludington on Lake Michigan. This is very close to 43° 50′ north latitude. Twenty-seven counties are included, with a combined land area of about 9,285,120 acres.

This particular region was chosen for study for several reasons. First, it is well known that it once supported one of the most remarkably heavy stands of pine timber in the world, and the contrast between the original heavy forest and the present devastated condition is marked. Second, only about 20 per cent of the area is in farms, indicating that agriculture has not even moderately taken the place of the forest. Third, the author is well acquainted with the entire region, and the data which have been gathered can be evaluated and studied with better judgment and understanding than if the region were unknown. Fourth, its boundaries are well marked: on the north, east, and west by the Great Lakes, on the south by a fairly sharp change to moderately good farming country (where 70 to 80 per cent of the area is improved). This exactness of delimination assists materially in ease of collection of data and in accuracy of drawing conclusions. Fifth, the region has been logged off long enough for methods of land utilization other than forestry to have been well tried. Further, the long period of time since lumbering was at its height (from 30 to 40 years) has allowed the effects of forest devastation to accumulate and to become decidedly evident.

That the region was in a decadent condition has long been recognized, but the extent of the decadence has not been measured. Now, however, with the aid of the information gained by the United States Census of 1920, this can be done with some accuracy.

Description of the Region

The soils are predominantly sandy, of glacial origin. Moraines, which cover perhaps 15 per cent of the total surface, are rolling to gently

[1] Summary written in collaboration with Professor Sauer, University of Michigan.

undulating in topography, with very variable soil, ranging within a short distance from stony and sandy to clay with but a few stones. On this soil type are most of the better farm lands, although as a result of its extreme variation continuous tracts of good farm land are not common. One may frequently find a few acres, even a hundred, in a body, but to find two or three sections or a township of such land is uncommon. Present farms as a rule formerly supported hardwood forests.

Another common formation are the till plains, the soil of which ranges from sandy loam to clayey loam, and is usually of second rate quality as farm land. Outwash sandy or gravelly plains, sandy drift, and sandy lake beds are the predominating soils. They are usually not farmed successfully. The original forest was largely white pine, Norway (red) pine, and scrubby jack pine.

There are no mountains; in fact great areas, so-called plains (or the "Siberians" in the parlance of the region) are level or very nearly so. Usually the soil of these plains is very poor. With few exceptions, the hills are not at all precipitous, and seldom rise more than a hundred or two hundred feet above the plains. Elevations range from about 600 feet to perhaps 1,000 feet above sea level.

Precipitation ranges from 25 to 30 inches a year, and most of it comes in the winter in the form of snow. Dry spells of a month to six weeks in the summer are not uncommon.

The flat, sandy land has not eroded appreciably, despite the heavy forest devastation.

Transportation and Markets

Facilities for transportation, are fairly good. There are 1,590 miles of railroads (common carriers) in the region,[2] and the area is three-fourths surrounded by the Great Lakes, which have open water for eight months a year.

Local markets for farm produce are only moderately good, for the population is mostly rural. The urban markets, Detroit, Chicago, Cleveland, and Milwaukee, are 100 to 200 miles distant and are easily reached by water or rail. The great producing farm area of the nation, however, is adjacent to these centers of population, and it is not easy for a north Michigan farmer, whose produce must come onto the market later in the season, to compete with the Indiana, Illinois, or Ohio farmers.

[2] From Michigan Railway Guide, March, 1922.

The markets for timber, however, are unexcelled. The great industries of Detroit, Cleveland, and Chicago are tremendous users of timber, and these, together with the great farm region of the North Central States, use nearly half of all the timber produced in the United States. Local markets for lumber, built up during the period of heavy lumbering, still remain to a considerable extent. Grand Rapids and Cadillac, Bay City and Saginaw, all of which include many large wood using plants, are adjacent to or in the region.

HISTORY OF EXPLOITATION

The story of the lumbering in Michigan pine is familiar enough to foresters, although it is given very scanty attention indeed in the written histories. The field notes of the surveyors of the General Land Office, who covered the territory between 1835 and 1850, told of the remarkable timber wealth. It is significant that they were very conservative in their estimates of the value of the land for agriculture. In fact, shortly before the Civil War, one made the statement that 90 per cent of north Michigan was worthless as farm land.

Lumbering started in Michigan in earnest immediately after the Civil War. The North Central and Prairie States were populated with extraordinary rapidity; cities sprang up like magic; railroads were stretched across the plains; and flanking them and streaming behind came settlers. Much lumber was needed, and the one place where a superior grade of building material could be obtained in limitless quantities, was the remarkable white pine stand in the southern peninsula of Michigan. There were no railroads into that region until about 1880; logs were driven down the rivers in the spring to the mills situated on the Great Lakes. Thus were the great mill-towns developed; Bay City, Saginaw, Au Sable, Alpena, Cheboygan, Manistee, Ludington, and Muskegon. Surprisingly small streams were dammed and flooded with logs. Lumber camps were everywhere in the woods. It is probable that each year between 1885 and 1890 there were perhaps 800 camps operating in the region.

Timber trespass of all kinds was common. "Rubber forties" were the rule, the lines stretching with the operation. Lumbering was feverish in its activity. Farmers by the thousand from the southern part of the State and from Ohio and Indiana traveled north into the Michigan woods in the fall to log. Half the lumberjacks, at one time or another, tried their own hand at operating camps. It was a booming flood of activity, carrying the forest relentlessly before it. He who was in it had

no thought of reconstruction, nor could he have done much if he had tried. Competition was severe, price of lumber was low, bankrtupcy was common, and few operators had money left over to put back into the region in the form of rebuilt forests. Failures were so frequent that the State legislature passed a lien law enabling the lumberjacks to hold the operator's logs until sold, and thus obtain some return for their winter's labors. To have protected slash lands from fires which swept onto them from other slashes would have been well-nigh impossible regardless of money spent. Lacking of telephones, roads, and equipment for rapid transportation, concerted action for fire protection during the summer was impossible; and further, there were but few people in the region during the summer.

Very few believed that the forest reservoir could be emptied. Every political speech resounded with broad phrases, ebullient, optimistic, regarding the inexhaustible timber wealth of the State, and every Michigander fully believed that no region could rival Michigan in forests. Up to ten years ago, when it was supplanted by the automobile business, the lumbering industry was, next to farming, the greatest industry of Michigan.

With the construction of railroads, timber which lay far distant from drivable streams, or which could not be floated (hardwoods) was reached cheaply and easily. The flat country made railroad construction simple and cheap; and extensive land grants by the nation (totaling to the railroads of this region very close to 2,100,000 acres)[3] rendered them rich. No stand of timber was inaccessible; the wood was exceptionally good for building purposes; the timber of almost ideal size to be handled; the market was immediately at hand and insatiable in its demand. It is no wonder, then, that the region was logged with such rapidity and thoroughness.

RESULTS OF FOREST DEVASTATION

Population

People moved into this region principally for two reasons, namely, to lumber and to farm. There are no fisheries (excepting a few along the lakes), and no great industrial or transportation centers. Population is typically rural, and generally of American stock. Excepting the children few were born in the region. Mostly they came from farms of

[3] From Special Report of the Michigan Railroad Commission, Lansing, Michigan, 1919, entitled, Data Pertaining to Railroads: An Outline of Development, Succession of Title, etc., by Edmund A. Calkins, Statistician. This is an exceedingly valuable and interesting compilation.

southern Michigan, Ohio, Indiana, Illinois, or from the great industrial centers such as Chicago and Detroit. Those from the cities are largely of foreign birth. In some localities French-Canadians, lured in by the lumbering, have stayed on as poor farmers. The so-called "habitaws" (near Alpena) are examples of these.

Table 1 indicates the number of people in the region.

TABLE 1.—*Population Changes in 27 Northern Counties.*

Year	Rural	City [a]	Total	Entire State	Entire State Rural
1860	7,800	.....	7,800	749,113	.....
1870	36,400	2,700	39,100	1,184,059	.....
1880	106,100	17,200	123,300	1,636,010	.....
1890	177,400	48,300	225,700	2,093,890	.....
1900	236,400	60,500	296,900	2,420,982	1,468,659
1910	251,700	73,800	325,500	2,810,173	1,483,129
1920	213,900	68,000	281,900	3,668,421	1,426,852

[a] By city is meant an incorporated town with over 2,500 population.

Twenty-three counties of the State lost more than 10 per cent of population in the past decade; 20 of these are in the cut-over lands of the southern peninsula (Table 2); the other three are in the cut-over lands of the upper peninsula.

TABLE 2.—*Population Increase or Decrease in 20 Counties.*

County	1900	1910	Increase or Decrease	1920	Decrease
			Per cent		*Per cent*
Benzie	9,685	10,638	+ 9.8	6,947	—34.7
Kalkaska	7,133	8,097	+13.5	5,577	—31.1
Antrim	16,568	15,692	— 5.3	11,543	—26.4
Cheboygan	15,516	17,872	+15.8	13,991	—21.7
Manistee	27,856	26,888	— 4.2	20,899	—21.7
Grand Traverse	20,479	23,784	+16.1	19,518	—17.9
Charlevoix	13,956	19,157	+37.3	15,788	—17.6
Iosco [a]	10,264	9,753	— 4.8	8,199	—15.9
Emmet	15,931	18,561	+16.5	15,639	—15.7
Oceana	16,664	18,379	+10.4	15,601	—15.1
Missaukee	9,308	10,606	+13.9	9,004	—15.1
Osceola	17,859	17,889	+ 0.2	15,221	—14.9
Leelenau	10,556	10,608	+ 0.5	9,061	—14.6
Ogemaw	7,765	8,907	+14.7	7,786	—12.6
Wexford	16,845	20,769	+23.3	18,207	—12.3
Oscoda [b]	1,468	2,027	+38.1	1,783	—12.0
Clare [c]	8,360	9,240	+10.5	8,250	—10.7
Roscommon	1,787	2,724	+27.3	2,032	—10.2
Alpena	18,254	19,565	+ 9.4	17,869	—10.5
Lake	4,957	4,939	— 0.4	4,437	—10.2

[a] Iosco county lost 32.7 per cent in population from 1890 to 1900.
[b] Oscoda county lost 22.9 per cent in population from 1890 to 1900.
[c] Clare county lost 5 per cent in population from 1890 to 1900.

Of the 27 counties studied 22 lost in population during the past 10 years. The decrease cannot be laid to crowding, for the average population per mile is about 20; and for one block of territory including ten counties or about 6,000 square miles, it is only 10. This is about the same as the average for the whole State in 1850.

The 1920 census of population was taken in January, at the height of the season for woods work, therefore the figures for this region are more likely to be too high than too low. It is probable that never before in the history of the United States has there been a withdrawal of people from a region so rapidly and in such great numbers as is evidenced here. Nor is the withdrawal confined to any one group, urban or rural, or to any particular part of the region—it has been general, and indicates that the sickness is not localized but is widespread, is not spasmodic but is chronic. Inasmuch as the wealth of the region is dropping very rapidly, and so far as can be seen will not again rise for many years, we may fully expect to see a further decline in population with the next census.

Social Conditions and Opportunities

One of the most sorry results of the heedless exploitation of the region, is its effect upon the social conditions of many of the inhabitants. We find farmers and tradesmen in many small towns caught in the ebbing tide of prosperity without money enough to get out to start business anew in a new region. They remain, many nearly destitute, and with the certain knowledge that as years go on their lot can only become worse.

Many of the farmers were lured into the region by unscrupulous land owners, who obtained the land very cheaply from lumbermen or from the State. Such men operated mostly in Chicago, Detroit, and other large cities, and often sold very poor cut-over land as the best of farm land. The ignorant and unsuspicious purchaser (who often enough was not much of a farmer) spent his few dollars coming into the region and starting his farm; when the farm failed, as it normally did, he had to get such work as was obtainable in the region and eke out an existence as best he could. There are a dozen or more families adjacent to the Higgins Lake State Forest who came into the region to make a living at farming on the warrant of an unprincipled land dealer, and have been able to remain only by obtaining work as day laborers, planting and tending the State forest. Several of these farmers have frankly told the custodian of the forest that either he must give them work or

they must become county wards. The State forests now furnish some of the supplementary work which logging previously supplied. The seven State forests of this area furnish the major part of the income of fully 50 families, most of whom originally came to farm.

Furthermore, many men as well as women, leaving their poor little farms, migrate to the cities in winter to obtain work. A survey of a number of farm homes in Crawford county showed that for several years the women had been going to the cities in fall to work as chambermaids and servants.

During the booming of the region many professional men, such as doctors, lawyers, and teachers, took up residence. Normally, as the professional man increases in skill through practice, his clientele increases in numbers and wealth. The contrary is true in the devastated regions. People are becoming fewer and poorer. The physician who established his home in a small lumber town, however skilled he might be, too often found that opportunity for advancement was not at hand.

Among those who are the more prosperous in the poorer counties, prosperity results in many cases not from the farm or trade but from some township or county office held in the family. In fact, the families of townships frequently take turns in holding the offices. Like Ben Johnson's sailors cast away on the desert isle, they make a living by taking in one another's washing.

Farms

The interrelation between forest and farm has often been noted, and was touched upon in the preceding paragraph. In this logged-off territory, the fact is that the farm, in many places, is more dependent for its success upon the forest, than the forest is upon the farm. Especially is this true on the poorer soils.

In the 27 counties there is approximately 1,720,700 acres of improved farm land. The term improved farm land as used by the Census included "all land regularly tilled or mowed, land in pasture which has been cleared or tilled, land lying fallow, land in garden, orchards, vineyards and nurseries, and land occupied by farm buildings." In 1910 the census returns 1,478,800 acres of improved land in farms; in 1900 996,000 acres. After half a century of endeavor at farming, during which time practically the entire area has been logged off and nearly every acre prospected by farmers to determine its suitability for farming, and after high persuasive efforts have been made by agricultural experts to prove the merit of the land for farms even to the extent of

abetting the unprincipled land dealers, we have but about 19 per cent improved. Furthermore we have in this region which *is growing in farm area,* actually 1,665 fewer farms now than in 1910 (32,557 in 1910 against 31,892 in 1920). Southern Michigan, as Illinois, Iowa, and other long-settled good farm districts, is losing both in number of farmers and in area of improved land; but in this sand plain district, the farm area is growing whereas the farm population and the number of farms are becoming less. It indicates that the farmer who does not have good land adjacent which he can purchase or develop, must succumb.

The average farm here has about 55 acres improved. In the better farm lands of southern Michigan, about 75 acres per farm is improved. Certainly the better farms of the south do not have too much land under the plow to secure a good living. To give a good living to farmers on the cut-over lands, fully 90 acres must be improved. In other words, at least 35 acres of improved land must be added to the average farm to enable the farmer to obtain a decent living. This means that more than a million acres must be added to the area already improved in the region.[4] Although no exact surveys have yet been made of the quality of the land for farming in these counties, there are several reasons why it is improbable that this amount of land will be cleared for farming: (1) the tendency everywhere is toward more intensive utilization of better land, rather than progression of farms onto poor lands; (2) to improve such an area would require fully $100,000,000, mostly in labor, and it is extremely dubious that such an amount of labor can be obtained; (3) the good land is so spotted on account of the glacial formation of the soil, that often the needed 35 acres is not adjacent; (4) the amount of land cleared yearly is much less than 10 years ago, from 1910 to 1920 averaging 0.2 per cent per year, whereas from 1900 to 1910 it ran about 0.5 per cent per year and from 1890 to 1900 nearly 0.6 per cent. Furthermore, as Dr. Sauer points out, only about 60 per cent of the improved land is cropped, whereas in better farm regions from 70 to 90 per cent is cropped yearly.

The point is, that farmers already poor as a rule, cannot hope very materially to remedy their condition through clearing of new land. The region cannot look to agriculture for its development. There are now as many farmers as can be supported by the available good land; and

[4] Dr. Sauer, Professor of Geography, University of Michigan, first worked out this interesting phase of land settlement.

because of the character of the soils and transportation facilities, they must remain poor if they depend upon farming. To bring in more settlers means to add more poor farmers, which is poor business for both the county and the State.

In this connection it is interesting to note the tonnage of farm products hauled on several railroads traversing the region (Table 3). Particularly, note the remarkable parallel between the decreases in tonnage of farm and of forest products hauled.

TABLE 3.—*Freight Tonnage Carried by Michigan Railroads, 1868-1917*[a].

Year	Grand Rapids and Indiana R. R.			Detroit and Mackinac R. R.		
	Total freight	Products of the forest	Products of agriculture	Total freight	Products of the forest	Products of agriculture
	Tons	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*
1868	19,470	13,656	1,943	.....	.....	.....
1871	193,930	117,966	22,098	.....	.....	.....
1880	540,251	330,087	70,839	.....	.....	.....
1890	1,607,255	894,718	113,726	.....	.....	.....
1900	2,089,469	1,098,272	222,878	915,988	709,080	27,893
1909	2,918,150	1,167,278	241,111	1,189,742	619,148	35,137
1913	3,618,793	1,372,760	278,752	1,072,183	479,334	51,062
1916	3,888,124	707,720	125,721	1,096,224	258,046	31,247
1917	4,091,742	665,584	100,522	1,135,839	308,752	32,764
	Michigan Central R. R.			Manistee and Northeastern R. R.		
1900	.....	1,686,107	.....	.....	.....	.....
1909	.....	1,921,583	.....	.....	500,201	21,697
1917	.....	962,587	.....	.....	344,301	23,998
1920	.....	[b]500,000	.....	.....	.....	.....

[a] From the reports of the Commissioner of Railroads (1868-1900), and the Michigan Railroad Commission (1909-1917).

[b] Estimated.

The figures from 1868 to 1880 are for freight carried on the entire line; those from 1890 to 1917 are for freight carried within the State of Michigan only.

Products of agriculture includes practically all products of the farm, except meat and other animal products. The larger amount of the tonnage is made up of hay and grains, which were hauled from southern Michigan into the region, probably largely for animals in logging camps. The region is exporting very little of farm products.

Products of the forest includes principally: lumber, logs, lath, shingles, posts, poles and piling.

There can be little doubt that forest devastation has been largely responsible for this undesirable farm condition. A great many farmers came when lumbering was in full swing, took up land, and were able to make a fair living by farming in summer time and supplementing the

income thus obtained by working in the woods in winter time. The lumber camps, too, offered an immediate local market for hay, potatoes, and oats, the staple products of the farms. With the passing of timbering, both the supplementary work and the local market were in large part lost. Of these, the loss of opportunity to work in the winter time was the more serious. Another result, less serious but often of considerable local concern, was the end of the supply of inexpensive stable manure. The farmer hauled this from the logging camps and used it to build up his impoverished and poor soil. With forest devastation came also a great reduction in mileage of railroads and wagon roads, making transportation very difficult for the small farmer distant from towns, especially in the winter season. The lumber camps kept roads open for hauling supplies.

Indirectly, the destruction of the forest was responsible for most of the crooked land business. Land dealers were able to obtain cutover lands from lumbermen or from the State at exceedingly low prices. Induced by glowing accounts of bumper crops, farmers came onto lands which no man could make a good living. Thus land was removed from forest production, while the land dealers insisted that it was good agricultural land, and would not have it said that it was better adapted to trees than to potatoes. Forestry was an art to be practiced on only the most damnable lands—certainly not on the good agricultural lands offered for sale by the hundreds of thousands of acres in Roscommon, Crawford, Alcona, and other counties. The land dealers succeeded in convincing not only local residents and State officials, but a great many foresters as well, that forestry was only for the poorest of poor sand lands. This notion still persists in the poorest counties, as a short talk with county officials will show; but it is interesting to note that in general county officials now are agreed that farming is out of place on the poorer lands, especially in the next county.

Prof. Roth, as early as 1907, saw the truth of the matter:[5]

"Opposed to this (forestry on the poorer lands) stands the precarious sand land or poor land farming in a cold climate, an enterprise full of uncertainties, with ever recurring failure; with poverty and hardship to those engaged in it; with a dangerous colonization of large areas by poor and helpless people; with no secondary industry or chance for labor.

[5] Roth, Filibert, State Investigation of Michigan Forestry Situation. Forestry and Irrigation. November, 1907.

"And all this for what? Merely to raise more potatoes in a State where we have now an over-abundance of farm products and are entering upon the throes of a timber famine."

There is no good economic reason why a man should be urged to pay $15 an acre for wild land which admittedly is of second quality and in a region of severe drought and frost, spend perhaps $125 to get it fitted for tilling and farming (clearing of stumps and stones, erection of barns, houses, fences, construction of roads, etc.), when for the same money, $140 an acre, he can get plenty of good land in long-settled farm regions.

Communities

The effects of forest devastation upon the communities of this region are particularly apparent.[6] A number of villages have entirely disappeared, and many townships which at one time were independent civically, have been consolidated with others. Of the 70 or 75 incorporated villages and cities in the counties studied, fully 75 per cent have fewer inhabitants now than in 1910. Many which were fortunately situated where hardwood forests were located, although they sank rapidly after 1890 when the pine was cut, rose with cutting of the hardwoods between 1905 and 1915. It was during this period, too, when great boosting of the agricultural possibilities of the soil was carried on. In 1900 25 towns had 1,000 or more population; of these 18 are smaller now than they were then. Of 20 towns which in 1890 had over 1,000 population, 9 are smaller now than then. Au Sable and Oscoda together, at the mouth of the Au Sable River, in the winter of 1890 contained about 12,000 people. In 1920, winter, Oscoda was no longer on the map, and Au Sable had but 171 people. This is an extreme result of forest wasting.

The decrease in population is only an easily determined manifestation of a reduction in the wealth and prosperity of the communities. Village decay is certain and obvious. Built during the hey-day of prosperity, many towns equipped themselves with water works, electric lights, traction systems, and other improvements which they cannot now support. Au Sable, "The City of Down and Out," is an often quoted extreme example. According to the story, in 1885 the town bonded itself for $150,000 to build water works, the bonds to mature in 1915.

[6] See in this connection: Dana, S. T., Forestry and Community Development. U. S. Agricultural Bulletin 638. 1918.

After the depletion of the forest, the expected agricultural boom did not materialize, and the town was left without adequate source of support. In 1908 the great Metz fires swept over much of the region near the city and in 1911 the town itself was burned. When the bonds matured in 1915, sufficient funds were not on hand to redeem them.

Practically all the cities and villages, such as Grayling, Manistee, Ludington, and Cheboygan, have various public utilities, either in community ownership or in private hands, all more or less in a state of dilapidation.

The towns struggle hard to maintain their position. They run strong to street fairs, to cajole people to spend money with the merchants. They boom the virtues of the soil for farming and the salubriousness of the locality for camping, hunting, and summer residence. The fact is that such towns will be better off if they forget their memories of the old lumber days and high prosperity, forget about water works and electric lights, and return to the back-yard pump, cisterns, and kerosene lamps. An ever increasing hope surges in the breast of the townsfolk of these backsliding towns, that sooner or later an auto factory, a glass works, and oil well, a salt mine, or some other source of wealth will materialize and bring prosperity to all. The town of Grayling during one year was alternately thrilled and disappointed by each of the above propositions.

Taxes and Land Values

Land values and tax returns are perhaps the best possible indices of the decadence of the region. To be appreciated, however, they must be compared with the land as it would be, if it were well utilized. To make it simplest, and to look at the region as a typically forest district, the land that now is neither utilized nor absolute waste will be considered for purposes of comparison as if forested. First, however, the present utilization of the land must be known (Table 4).

We may thus block out the utilization, for purposes of valuation, as follows:

	Acres
Well utilized, or exempt from valuation	3,081,738
Non-productive waste land	200,000
Forest land, cut-over, practically unproductive	6,003,390
	9,285,128

The total values of the region, as given by the State Auditor-General's reports, are: 1919, $163,300,000; 1914, $185,300,000; 1911, $166,400,000. If the 6,000,000 acres of present wild land (practically

unproductive) were in forest, it would have a present valuation, at an average of $40 an acre, of $240,000,000. At present, this land is assessed at about $5 an acre (ranging from $2 to $8), and has a total value of about $30,000,000. The farm land and villages make up the rest of the valuation given, $133,300,000.

TABLE 4.—*Utilization of Lands of 27 Northern Counties of Southern Peninsula.*

	Acres
Total land area	9,285,128
Improved land in farms	1,720,000
Railroad rights-of-way	[b]12,800
Townsites and roads	[b]100,000
Marsh, non-agricultural, non-forest, and waste	[b]200,000
Hardwood forest, privately owned (most of which will be cut within five years)	[b]200,000
Swamp and upland, with fair timber (low growing stock and poor yield)	[b]500,000
Michigan National Forest	68,632
Michigan State forests (under management)	95,006
State owned, in form of tax homestead [a]	277,800
U. S. unreserved public domain	17,500
School, college, swamp land grants from U. S. to State, State owned[a]	[b]60,000
Military reservation (State) and State parks	[b]30,000
Total	3,281,738
Forest land, practically unproductive at present	6,003,390

[a] Most of the tax homestead and land grant land is held by the State for forestry purposes, but until it is placed under management, no care is taken of it other than a modicum of protection against timber trespass. No special efforts are made to protect it against fire.

[b] Approximately.

The following figures, obtained from county tax records for Otsego and Crawford counties (1922), indicate the difference in assessments of wild land and of present hardwood forest land. They will give an idea of the present values of the two classes of land.

TABLE 5.—*Comparison of Assessed Values and Taxes for Forested and Cut-over Land.*

Area	Valuation—Board of State Tax Commissioners		Total tax, including State, county, and township taxes	
Acres	*Total*	*Per acre*	*Total*	*Per acre*
[a]40	$2,500	$62.50	$59.07	$1.47
[a]40	1,550	38.75	36.83	.92
[b]80	200	2.50	5.76	.072
[b]40	100	2.50	2.31	.057
[b]40	120	3.00	4.82	.12
[c]40	300	7.50	9.17	.24

[a] Good hardwood forest. [b] Cut and burned over. [c] Hardwood land, cut and burned.

Millions of acres can be purchased for less than $3 an acre. One lumberman last winter offered his cut-over land holdings for $1.75 per acre.

From the 6,000,000 acres we are obtaining probably not much more than $750,000 in taxes. If it were forested, and the tax rate the same, we would get about $7,500,000. To obtain the same total amount of taxes if the area were forested, we would have to tax at but one-tenth of the present rate, or about two-fifths of one per cent instead of the present 3 to 5 per cent.

As the value of taxable property diminishes and the demand for taxes for improvements remains constant (if it does not increase), the tax rate must be raised to meet the difference. Witness the average rates of taxation of property in representative towns in the region (from Report of Board of State Tax Commissioners) compared with the rates for typical cities in southern Michigan (Table 6).

TABLE 6.—*Tax Rates for Representative Cities in Northern and Southern Michigan.*

Northern Michigan	Rate per $1,000 of value		Southern Michigan	Rate per $1,000 of value	
	1912	1919		1912	1919
Alpena	$22.71	$31.79	Adrian	$24.99	$24.80
Au Sable	35.96	78.59	Albion	31.53	30.66
Boyne City	31.93	48.90	Alma	32.32	21.64
Charlevoix	32.98	41.14	Ann Arbor	20.05	25.91
Cheboygan	40.76	45.07	Battle Creek	27.34	25.00
Clare	19.99	33.46	Detroit	23.37	24.01
East Tawas	51.46	71.52			
Harrison	35.22	47.77			
Onaway	39.10	54.97			
West Branch	30.90	40.31			
Tawas City	56.05	43.56			

These figures indicate a decided rise in tax rates, despite an increase in basis of assessment from two-thirds value in 1912 to full value in 1919. In 1918 most of the cities were assessed higher than in 1919, probably because of war inflation.

The average rate of taxation for all purposes per $1,000 of assessed valuation for the 27 counties was about $31.75 in 1919. Of 14 average counties of the southern Michigan farm region the rate was about $22.30 per $1,000.

Even more striking, perhaps, is the extent to which the counties fail to bear their share of the burden of State taxes. Twenty-five of the

twenty-seven counties have no reason to complain that their State taxes are burdensome. In the fiscal year 1918 they drew more money from the State treasury for the maintenance of their primary schools than they paid into it in the form of State taxes.

All taxes paid by railroads, car-loaning, express, telephone and telegraph companies, inheritance fees from estates, escheated estates, and insurance taxes are paid into this primary school fund, which is apportioned to each county according to the number of children in the county. The 25 counties drew from the State treasury for primary schools $177,600 more than they paid in State taxes. The other two counties, Roscommon and Grand Traverse, together paid in $404 more than they received. Wayne county, which includes Detroit, put in $1,248,446 in excess of its apportionment. Only a few other counties in the State were delinquent in this way for taxes for their school children.

Several counties failed materially to meet the burden of State tax apportioned to them. Alcona county paid only 73 per cent of its State tax, Benzie 81 per cent, Lake 72 per cent, and Roscommon 54 per cent. The area as a whole defaulted by about 12 per cent, compared with 4 per cent for the rest of the State.

It is certain that he who indulges in any form of development in this territory, whether farming, forestry, or industry, must be subjected to severe taxation. The country is getting poorer, but the desire for good roads and other improvements, to keep up with progress in other parts of the State, urges higher and higher taxes. As a result, the few poor farmers must pay high for the privilege of eking out a precarious existence on the sand lands. The higher the taxes the fewer the farmers, and the fewer the farmers the higher the taxes. This theoretical conception of a vicious circle is, in all seriousness, entirely true here.

More and more, too, is cut and burned over land being allowed to revert to the State for taxes, and all evidence indicates that this process will continue. There is now in the region about 279,000 acres of State tax and swamp land, reserved for forestry purposes, and about 6,000 acres is being added yearly. The large land owners were probably fooled as to the agricultural value of the land. They apparently believed that sooner or later agriculture would find a use for the poor sand lands. Thousands of sheep were shipped into the region for grazing on the man-made "plains;" one wealthy lumberman fenced several thousand acres and ran cattle on the tract; ranch companies were organized, sold

stock, and ranching boomed. To no avail. The ranches are deserted, the sheep and cattle gone. This winter one large land owner, in response to a query as to why he persisted in holding his land, paying taxes, replied vaguely that perhaps he could get rid of it for a ranch or hunting preserve some day.

Relief from high taxes may come through cutting down county and township administrative costs by combining townships and counties into larger civic units. To handle these poor counties as the usual counties are handled, involves loss of money, misguided efforts, and poor results. The total tax for all purposes (State, county, and township), raised in the seven counties of Alcona, Crawford, Iosco, Montmorency, Ogemaw, Oscoda, and Roscommon, was $756,000 in 1918. Approximately $232,000, or about 30 per cent of all taxes, is spent each year in these counties largely for salaries of county and township officials.[7] By combining civic units fully half of this sum could be saved. In the past 30 years, 20 township units lost their identity, being merged with neighboring townships.

Railroads

Above all other businesses in a region where lumbering is the chief enterprise, the railroads feel most keenly the effects of forest devastation. The amount cut yearly is reflected immediately in their earnings. Competition between roads, furthermore, is severe. Even though the area were to remain continuously productive of timber, there is little doubt that some roads would be forced out. With the aid given by State, Nation, and municipalities, many railroads were developed which under other circumstances would not have been. The several roads together were given about 2,100,000 acres, which they might have sold without question for around $7.50 an acre, or $15,750,000 in all. This was a subsidy given for building not over 1,000 miles of track, which cost not over $12,000 a mile, or a total of $12,000,000. This leaves $3,750,000 as profit or bonus to the railroads.

The terrain makes construction easy, and the roads were built only as rapidly as new sources of timber needed to be tapped to develop freight. In short, between having their lines built for them at a profit to themselves, domination of the land so that other outfits were often balked in their efforts to come in, entire control of rate of production,

[7] This does not include taxes for the State, schools, highways, county roads, drains, city or village.

and a market that could not be satisfied, the railroads could have no fear of losing money. As a result, many lines were built which immediately gave profit to the owners and which were abandoned without hesitation when the main source of freight, the forest, was depleted.

In 1910, which was near the maximum for railroad tonnage in this territory, three railroads, the Grand Rapids and Indiana, the Detroit and Mackinac, and the Michigan Central, carried approximately 3,500,000 tons of forest products. This was one year's production from approximately 4,000,000 acres of forest (in 1910 little or not rafting was done, and practically all timber cut was taken out on the railroads). Under sustained annual yield, this same 4,000,000 acres would supply fully 4,000,000 tons of green logs, in addition to perhaps 1,500,000 tons of finished products, or a total of 5,500,000 tons. In 1920, the same railroads carried not over 1,100,100 tons all told, of forest products, or only one-fifth as much as they might have carried if the forest had not been devastated.

Other tonnage has not taken the place of that lost through depletion of forest supplies. The forest products hauled by the Grand Rapids and Indiana and the Detroit and Mackinac Railroads in 1917 amounted to approximately 975,000 tons; in the same year the tonnage of farm products from the same lines was only 133,000. The decrease of farm population and number of farms and the obvious decline in values of taxable property and in number of inhabitants of the cities indicates, without question, that the tonnage of products, other than those of the forest, will become less in the future. In short, the prosperity of the railroads, which was at its height during the boom lumber days, is now on the wane, and has been for ten years. The Michigan Central Railroad north of Bay City, built between 1871 and 1881, hauled on an average 1,200,000 tons of logs and perhaps 400,000 tons of finished forest products each year from 1887 to 1917. In 1921 it hauled scarcely one-seventh as many tons of logs as in 1890, one-third as many as in 1916, and only half as many as in 1919.

The truth is that practically all the railroads in this large area (an area about as large as Massachusetts, Connecticut, and Rhode Island together) are operating at a loss. A high official of one road remarked recently that it would be good business for his directors to order their tracks rolled up and burned, wiped off the map, because the source of its business and the reason for its existence, the forest, has been destroyed.

To do so, however, would leave about 5,000 farms and perhaps 50,000 people without transportation facilities.

The State Public Utilities Commission at Lansing is constantly in session, hearing pleas of railroads which wish to abandon trackage rather than operate at a loss. In 1922 the Pere Marquette (the largest railroad system in Michigan) had a petition before the Utilities Commission to be allowed to abandon 72 miles of track. To quote from the press reports (Ann Arbor Times-News, January 10, 1922):

"The railroad already has an order from the Interstate Commerce Commission at Washington, to stop service and tear up the rails. The consent of the Michigan Commission, however, is necessary before service between any points within the State can be stopped.

"All these lines once served a thriving timber country. Now that the lumbering days of Michigan are over, there is not enough business to warrant operation, the railroad contends.

"The application of the Pere Marquette, of these four abandonments are only the forerunners of a number of similar applications which will be filed in the near future.

"Opposition to the abandonment comes from villages along the line which claim that they will be without any transportation service whatever if the railroad is permitted to stop its trains."

One scans the time tables in vain for mention of railroads which even 10 years ago were flourishing. The Manistee and Luther, the Manistee and Grand Rapids, the Ludington Northern, all are now abandoned.

When the few remaining stands of hardwoods are cut, as they will be within five years, we may expect to see a wholesale abandonment of railroads. As it is, during the past 31 years fully 1,400 miles of railroad have been abandoned in this region.

Period	*Mileage abandoned*
1880–1890	84.30
1891–1900	429.00
1901–1910	374.90
1911–1921	352.30
Total	1,240.50

These figures do not include the Michigan Central, from which no figures were available. Including it, the total would be fully 1,400 miles.[8] The figures include woods spurs a mile or more long; but the great bulk of the abandoned track was in units of 10 to 45 miles.

[8] Data were obtained directly from railroads and checked against information obtained from E. A. Calkins, statistician of the Public Utilities Commission.

Evidently a great many miles of short spurs were not reported.

It is probable that by 1935, unless rigorous efforts are made to rebuild the forest, there will not be over 1,200 miles of railroad in the region. The Detroit and Mackinaw up the east coast, the Michigan Central through the center, and the Pere Marquette and the Grand Rapids and Indiana on the west coast. These with their branch and connecting lines, will be all that is left of fully 3,200 miles of railroad built.

The cost of reproduction of such track as was torn up, according to the chief engineer of the Pere Marquette, is about $13,000 a mile. The 1,400 miles abandoned would cost $18,000,000. This is a fair indication of the efficiency and enterprise of uncontrolled *laissez faire* in the development of a forest region. Here development and destruction are synonyms.

Lumbering

The lumbering days of this region are over, and will be for a great many years to come. A region that 60 years ago contained approximately 125,000,000,000 feet board measure does not now carry more than 2,500,000,000 feet; and of this nearly 2,000,000,000 feet is hardwood. There is no pine in quantity left. In 1890 there were approximately 700 lumbering camps in the region, and in the neighborhood of 25,000 loggers. Today there are not more than ten camps, and not over 500 loggers.

In no place do we find any quantity of second-growth of desirable species taking the place of the previous stand. A little trembling aspen, a few scrubby jack pines, bush oak, and in the swamps, pole and post size cedar, have taken the place of the old forest. Such a statement as this (from a recent magazine article discussing present measures of forestry for the nation) is of mighty small truth with us: "Little more is needed than protection against fire, and a suitable fiscal policy, to give anew forests that will meet all the wood requirements of their people."

There are misconceptions regarding the desirability of jack pine. Many feel that this species can be considered a good replacement tree. This is not true. Jack pine is a poor imitation of a real forest tree. Any site that will grow good jack pine in this region, will grow much better Norway or white pine. Jack pine, at its best, makes poor box boards. Its saving grace is that it is hardy and grows industriously in

its youth. It soon tires, however, and a jack pine 14 inches in diameter and 60 feet tall is a big one with us. If it stands dense enough to prune well it stagnates; and if given enough light to grow rapidly, it is limby.

The poplars, oaks and maples which are found in abundance in some places on the cut-over lands, do not form lumber trees. They furnish at best posts, ties, and pulp, and utilize the productivity of the soil poorly.

It must be remembered that this region at one time supported exceedingly heavy stands of white and Norway pine. Fernow [9] reports a number of stands that scaled from 60,000 to 90,000 feet board measure per acre; and sections were common that ran from 30,000,000 to 40,000,000 feet. It would appear to be the part of foolishness for foresters to advocate poplar and jack pine on such land.

It is probable that fully 95 per cent of the upland pine type will have to be planted, if white pine or Norway pines are desired. Seeding from lone seed trees has failed. Practically all of the upland on the Michigan National Forest must be planted.[10]

The capitalization of the lumber industry of Michigan was about $121,000,000 in 1890; in 1914, despite advancing prices and development of large wood-using plants which obtained much of their raw material from outside the State, the capitalization had dropped to $56,000,000. In 1890 the value of the products was $118,329,075; in 1910 it was $57,612,225, and in 1919 (peak of high prices) $88,891,000.

If the region were well forested and a going forest business, approximately the following number of men would be employed on the 6,000,000 acres of forest land.

Foresters and forest laborers (plus 10,000 additional for six months)	1,000
To log out the product	8,000
To manufacture the logs into lumber	10,000
For further manufacture into commodities of trade	20,000
	39,000

The number of wage earners from this one forest region thus would be greater than the number in any other industry in Michigan, as it is

[9] Fernow, B. E., The White Pine. Bulletin 22, U. S. Dept. of Agriculture, 1899.
[10] Letter from R. G. Schreck, Forest Supervisor, April, 1922.

at present, except the automobile industry. Besides the wage earners who would obtain their principal income from the forest, 15,000 farmers could find four months' work here each year to supplement their farm incomes.

In contrast to these 40,000 wage earners who might be employed continuously on the 6,000,000 acres under consideration, we find that the number of employees in the lumber and timber products business has decreased steadily since 1890. In that year there were about 54,000 in the whole State engaged in logging and milling; in 1900 the number had dropped to 40,528, in 1914 to 28,527 and in 1919 to 21,660. In 1919 there were 618 establishments, against 1,180 for 1910.

The stumpage from this 6,000,000 acre forest would sell each year for $30,000,000 (at $15 per thousand feet b. m.), and the product as lumber would be worth fully $100,000,000 each year. An area which might be producing 2,000,000,000 feet yearly is now producing not over 200,000,000 feet and by 1930 will not produce, in all likelihood, over 20,000,000 feet. This will come mostly from the swamps (which are to some extent fire proof) and from such small jack pine as is at hand.[11] We are safe in assuming that by 1930 this region, which might supply itself with its forest needs many times over, will import timber, and at a fabulous price.

The drop in lumber production has come with amazing swiftness. Even the most dreamy forester, "denudatic," of 12 or 15 years ago, did not believe that this part of Michigan would be as destitute of forests as it is today. It was said that the area was large, and that doubtless forests not commonly seen were left. It was felt that there always would be some forest, and that sooner or later we would get the forest fires checked and trees would grow. Reckoning was not made of the exceedingly easy accessibility of all parts, nor of the extreme prevalence of forest fires, which were not stopped, and in fact are no more stopped today than they were 30 years ago. Essentially, a reservoir of timber continues to supply with no lowering of head until the last drop has been drained.

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[11] The swamps are now essentially on a sustained yield basis. Composed largely of cedar, balsam, and cottonwood, they reproduce well. Material is cut when pole or cord size on a selection system. The forest persists, except when burned, but the quantity of the growing stock is about a quarter of what it should be. It will take fully 60 years to build up the growing stock.

The industry holds strong to the end, and then drops abruptly. There is little opportunity for gradual readjustment of business, of putting the house in order, of building new forests, before the fall comes. The region as a whole prospered to the last; now it is destitute. There is no possibility of it recovering for fully fifty years. The simple truth which people could not believe would ever be, has actually come to pass, the forest *is* gone, and nothing commensurate with it is taking its place.

Another interesting feature of this forest devastation is its effect upon the small winter operations carried on by farmers and small jobbers in the jack pine and in the swamps. At present the farmer can reach a railroad moderately handily, at no great distance from a mill. With the abandonment of the few remaining mills, and railroad spurs that reach into the woods, the small operator will find that the long hauls seriously lower his profits or completely confiscate them. It will materially hinder the utilization for farms of good lands at a distance from railroads (through lack of this supplementary work), and without question will force more farmers to leave. It also precludes many small forestry operations through lack of handy transportation, mills, and markets.

Effects of Forest Devastation Upon Recreational Values

We have here a region that is nearly surrounded by the cool Lake Michigan and Lake Huron. It is in the same latitude as northern New York and Bangor, Maine. It lies adjacent to the densely populated region of Indiana, Illinois, and Ohio, where sweltering days and suffocating nights are the usual thing in the summer time. To escape, the residents who can, travel to cooler regions, and they naturally travel north. This north Michigan district is sandy. Roads do not become impassable on account of mud, and one may travel by auto at any time in the summer over the poorest of the roads without fear of getting stuck either in sand or mud. Flies and mosquitoes are not more numerous than in any other northern coniferous region. Snakes are rare, and chiggers and ticks are unknown. Streams, lakes, and beaches are abundant; good water is handy everywhere. It is an ideal playground for children. It is easily and cheaply reached by boat and rail.

It is, however, at present not nearly as well used as it would be if forest devastation had not occurred. This is evident for several reasons.

1. In most parts of the region it is nearly impossible to get fresh

milk or vegetables. Without these, there is little attraction to families with children. This, of course, is due to lack of farms; and as has been pointed out, the scarcity of farms may be laid directly to decline of the lumber industry.

2. The repeated forest fires have removed the beauty of the tree growth from the land. A desolate, destitute picture does not entice. People naturally enjoy homes under the shelter of great pine trees. One is not happy when exposed in an oak brush field. This doubtless is the main reason for scarcity of recreation seekers in the region.

3. The menace of the forest fire creates a hazard that with good reason frightens away many recreation seekers. No man will build a summer home on the shore of a small lake or stream, isolated, when it is almost certain that within a few years it will be destroyed by fires.

4. Very few good roads are maintained, owing to the abandonment of the region by lumbermen and farmers. The exceedingly crooked "plains" road, winding its way around stumps, a single rut cut through the sweet fern and sod, the bumpy corduroy crossings over swales, repel the usual traveler in an automobile. Night traveling is almost out of the question to the stranger. Under the present condition of the region, we cannot expect good roads, unless built by State or Nation; and if built, the counties cannot be expected to care for them.

The recreational value to the residents of this district is without question fully $4,000,000 a year; it is worth a million to a million and a half to the railroads. Furthermore, the money spent would largely go to farmers and to townspeople who need it badly. At the present time, perhaps not a fifth of that amount is spent here for recreation, mainly because the forests of pine are gone.

CONCLUSION

The data and conclusions given here regarding the effects of forest devastation in one part of Michigan are scattered and fragmentary. They are in no wise complete. In truth, many of the manifestations of a decadent forest area which have been detailed, are only as surface indications of mineral veins. They are as "float," indicating need of further search, but not telling the whole story. The leads have not been followed exhaustively; the extent of the main body of the ore has not been determined. Much evidence has not been found; value of other data examined perhaps has not been realized. But they do show

that the area is not in a healthy condition economically, and what is more, perhaps, that its condition is likely to become progressively worse under present management. One fact that we have dodged and would not realize, a truism we have hoped was not true, is now revealed to us with certainty. It is this simple fundamental: He who devastates a forest does not rebuild it. Our Michigan forest lands are not being reforested by the owners, they are not given a pittance of care. *Not one* owner is doing so, we do not expect any to do so in the future. Three billions dollars worth of forest products have been taken from the lands of Michigan. Not one hundredth of one per cent of this amount has been spent by the despoilers to rebuild the forests. We feel justified in concluding that the people are faced with two alternatives, namely, (*a*) leave the lands in unobligated private ownership and expect them to go further and further into desolation and ruin, a continuous liability to the State, or (*b*) remove the lands from private ownership and rebuild through the efforts of all.

These data show also that the decadence of the region is definitely linked up with the passing of the forests. Without restoration of the forest there can be no restoration of the region. A prosperous forest business is *sine qua non* to prosperity of the people. This is a fact of tremendous importance. It means that agriculture has failed here, that immediate profits cannot be obtained, and that prosperity lies only for the indefinite future.

A people who for 60 years have thought only in terms of forest destruction on a huge scale, do not easily reverse habits of thought and think in a diametrically opposite direction. Realization of the need of immense, costly, slow forest rehabilitation will come gradually. The bad effects of forest devastation are assuming such large proportions that no one can escape seeing them.

THE PROFESSION OF FORESTRY AND PROFESSIONAL ETHICS

By Herman H. Chapman

Vice President, Society of American Foresters

The ethics of a profession may be compared to salt; it keeps it from spoiling. It is the most potent factor affecting the efficiency and influence wielded by said profession. What are professional ethics? and what are the ethics of the profession of forestry? This is no new subject for foresters. The Society of American Foresters, and some of its officers, have given much thought to the subject, and on one or two rare occasions foresters have been expelled from membership for violation of professional ethics. Yet there is no formulated, written professional ethical code for foresters to grade either the Society or the individual in their conduct. It is ovbious that a code of ethics represents a concensus of professional opinion rather than individual preferences. If each man did what was right in his own eyes regardless of the opinions of others there would be no code or standard in existence.

In the second place, and here I believe we extract the meat from the cocoanut, such a code must be based on the interests of the public or society, and not the self-interest of the individual forester. A profession as a body of trained specialists has for its primary, general, or professional objective, service to society. The ethics of a profession are those principles of conduct which insure the faithful performance of this service, and as such, establish the reputation of the profession, extend its influence, and multiply its opportunities for service. The reaction from this benefits the profession itself, increases the opportunities for employment and the salary scale, and makes the profession more desirable.

In common with all professions, that of forestry encounters the incentive of self-interest, which tends to seek personal advancement or financial profit by direct short-cuts and often by sacrificing public good, public interests and public confidence. To just the extent that public welfare is jeopardized or damaged by such a course, or the reputation and usefulness of the profession are lowered, the ethics of the profession have been violated. In a case in point, a public official

extended his approval to a prospectus issued by a company soliciting money from investors for planting eucalyptus, when the concensus of professional opinion, later born out by experience, showed that such investments were unsafe if not positively fraudulent. In another instance of recent occurrence, it was known that a State official, not a forester, was in receipt of a salary of $5,000 annually from private land owners, in addition to his pay from the State, though this official had as his duty the enforcement of certain regulatory laws affecting owners of forest land.

The ethics of foresters in public service are clearly understood and accepted by the profession at large, and have been adhered to so uniformly and rigidly that as a result there is probably no body of public servants which stands higher in general esteem than National and State foresters. There are few if any such public foresters who would be willing to deliberately compromise or disregard the public interests which they are paid to protect, even if the pressure for such a course became so strong that they had to choose between yielding or resigning.

The debatable ground in the ethics of forestry does not lie in public service but in private employment. It is the purpose of this article to attempt to outline the problem which here confronts us. While the forester in public service owes his full allegiance to the public, and any departure from this course is black treason, qualifying him for immediate expulsion from the Society, the forester in private employ has a divided allegiance. As a paid employee of a private corporation, his duty consists of carrying out, not public policies, but those determined by his employers, regardless of their effect on public welfare. But as a professional forester, such policies as his employers are practicing may not even be good private forestry, much less good policy for the public to permit. Thus the forester in private employ may find himself in much the same position as a lawyer retained by a corporation to help them evade the law, or to defend a criminal of whose guilt he is convinced. The requirements of his employer and his duty to the public may clash. Or he may find that he is impotent to correct conditions obviously wrong and wasteful. Private forestry on a sound basis of timber production by growth must come about through the altered viewpoint of the land owner crystallized into practice and surmounting the obstacles interposed by fire risks, tax risks and the greatest risk of all in the private mind, the abnormal delay or span of time in crop production on denuded areas, coupled with the almost irresistible temptation to speed up or realize on the present forest capital.

Are professional ethics impossible of practice by the forester in private employ? Or, if they do apply, must they be modified, and a different standard set for him from that accepted as applying to public service? In the past this issue has been clouded, even muddied, by violent attacks on the public ethics of those engaged in the business of lumbering. These destructive pirates and timber butchers, said the critics, had no thought whatever for public interests but sought only their own enrichment, and the future of much of the forest lands in their ownership was permanently ruined. Perfectly true, but what of it? Did lumbermen, acting thus destructively, violate any business ethics? And what code of ethics governs the conduct of a great industry, any way, a business or a professional code? These critics have been condemning the lumber industry for violating a code of professional ethics whose keynote is public service, whereas, in any business, so far as I know, the business code consists of conducting your business honestly, playing fair, treating your employees decently, serving the public by delivering finished goods of excellent quality at reasonable prices, and utilizing the raw product in a close and economical manner. Furthermore, the success of a business is based on private profit and measures which appeared to have the effect of reducing this profit without promising adequate future returns violated this principle of profit. A private business is not a public business, neither are private business ethics identical with the ethics of public service. When the time comes that foresters can demonstrate to private operators that it is more profitable for them to maintain the productiveness of forest land than to destroy and abandon it; to earn interest on a permanent investment than to pay back depreciation on a transitory business; then the principles of private profit and of public service will be brought more into harmony. When there is no longer any way to obtain timber short of growing it, there will be no private lumbering unless preceded by either private or public forest production. So this question is on the way to being worked out.

In the meantime we have to account for the phenomena which have so confused the public mind. They never will understand these phenomena and the lumbermen can never give to the public an explanation which will remove their suspicions. These phenomena are: inconceivably extensive destruction of forest resources by excessive cutting and uncontrolled fires, resulting directly from the logging operations, caused directly by the lumbermen, *but for which neither the individual lumbermen nor the industry could be held primarily to blame.* In creating

this condition they violated no principle of private business ethics, nor did they violate any public laws, and as far as most of them knew they were operating on correct business principles, under close competition and barely squeezing out a profit as it was. Of course there was public loss and damage. The unchecked operation of private industry, while securing tremendous benefits to the public by reason of efficiency and lowered costs of production, is accustomed to disregard certain broader and more far-reaching aspects of public good embodied in the protection of fundamental resources, and even the conservation of human welfare. Immediate profits are reduced by such measures. It is just on such points that the common objective of service to the public is lost, and a divergence between private gain and public good appears. It rests with the forester in public service to steer the course of public legislation so as to cope with this purely economic problem, for only through a combination of wise and timely public acts, improved economic conditions and private understanding and foresight, can any real progress towards the cure for this condition be made.

Meanwhile, no industry after the need and possibility of progress are manifest can afford for purely selfish reasons *to actively oppose reasonable public measures looking towards cooperation and upbuilding of future conditions.* Whatever may be true of the primitive past, the present and future will not brook such an attitude, and those lumbermen who either individually or collectively oppose or discourage efforts to find a reasonable solution which will bridge the rapidly widening chasm between private destructive lumbering and public interest in forestry will no longer be excusable on the specious plea of impracticability of such measures, but will stand as exponents of private greed consciously and deliberately opposed to public good. There has been recent testimony before the U. S. Senate Committee unmistakably revealing this reactionary attitude. The only rational explanation for such a pose at this time is a short-lived industry, a stock of timber soon to be exhausted, and a blind indifference to what happens after logging is completed and the wheels cease to turn.

This leads us to the consideration of the final question, the standard of professional ethics of the forester in private employ. It is our belief that the matter can be sized up about as follows: If a forester is to remain professionally a forester, regardless of his employment, it is necessary that he retain a professional standard of ethics. This requires that he understand and hold to the principles of forestry

which affect the public good wherever this comes in conflict with private greed.

But if this forester is privately employed on a salary, and is under orders as to what manner of work he shall do or measures he shall enforce in the woods, and the work which he thus directs does not conform to the standards which he believes represent forest conservation, and he chooses to remain on the job, he does not, by retaining this sort of a job, lose his standing or impair his professional ethics. He is free to use his powers of persuasion on his employer to secure better methods. He is not required nor should he be expected to become an advocate before the public of measures hostile to public good and of questionable private benefit.

But when a forester in private employ, a member of the Society of American Foresters, with full understanding of the standard of professional ethics required of a forester in good standing, loses sight of his professional duty as a forester and because he is a private employee or a paid representative of private business expresses himself publicly and in a manner intended to influence public opinion; when in so doing, he deliberately opposes measures because they are opposed by his employers, when as a forester he knows that such measures are necessary for the public good and could be carried out without unreasonable loss to private industry; when a forester who knows better becomes the paid mouth-piece of private industry in opposing or delaying needed progress in constructive forestry, and in so doing misrepresent facts or twists economic principles, or distorts the viewpoint expressed; then such a forester, while "true" to his employer, and while undoubtedly doing what he is paid to do, thus earning his salary, is no longer true to the profession of forestry, and has violated professional ethics as grossly as the public forester who accepts bribes for failure to enforce regulating legislation. His only proper course as a professional forester would be to resign from the Society, or else refrain from publicity and permit those who are not sailing under false colors to represent the anti-public activities of business.

With the principles as outlined there can hardly be much dispute. The trouble comes in applying them and in determining in a given case whether a serious violation of professional ethics has occurred. This requires a knowledge of economic facts, as well as of principles of conduct. Foresters whose knowledge of actual facts convinces them that legislation proposed in public interest is futile or even vicious are performing a public service in opposing it. But this applies to concrete

measures. Foresters may even conscientiously oppose all regulatory legislation and still be within the pale of professional ethics, if they believe professionally that the time is not ripe for it or that it cannot be worked. But a forester who defends an absolutely untenable position because of his interests, or one who, after being informed of definite facts which are beyond dispute, makes a public statement directly contrary to said facts because it is not in his employer's interest that such facts be known, is in a different category.

The privately employed forester is in a difficult position, and may often be embarrassed or discouraged by the attitude of his employer. But by virtue of his professional education he is supposed to be able to digest economic facts and to understand what constitutes the ethics of his profession. This lays on him a responsibility not shared by the lumberjack, or by the logger or lumberman. He can remain true to this standard regardless of his surroundings, provided he retains his belief in the principles of public good as well as private profit, and provided his privately expressed opinions and public utterances, when he makes them, conform to this standard; or provided he refrains from expressing opinions or public utterances which violate this standard. When the opposite occurs, he is prostituting his educational training, professional reputation, and ethical standards, in order to defeat the good of the public and prevent the successful consummation of proper measures for public welfare, and should join the ranks of those who can do this with a clear conscience, because they have no professional ethics to uphold.

One of the greatest services which the Society of American Foresters can render is to require of its membership a strict adherence to a reasonable standard of professional ethics, and if gross violations of this standard occur, to expel the offending member. Otherwise, membership in the Society will come to mean very little. Only those who can reasonably be expected, by temperament and training, to adhere to such a standard, should be proposed for membership in any grade. The inclusion of any large number of persons as members who neither understand nor are actuated by a standard of professional ethics must in time so weaken the fiber of the Society that it will find itself torn by conflicting interests or degenerated into a loose federation of sections with no common principles. Whether or not such a standard can or should be reduced to writing and adopted formally the writer is not prepared to say at present. The most important truths are sometimes intangible.

FOREST ENTOMOLOGY AS A SUBJECT OF IMPORTANCE TO FORESTERS [1]

By H. B. Peirson

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REASON FOR OUTBREAKS

Great changes have taken place in the composition of our forests during the last 100 years. Fire and methods of cutting are tending more and more to specialize the type of forest grown. Dominant and insect resistent soft wood species which at one time occurred in large stands have been repeatedly cut and less resistent species allowed to come in and make up ever increasing percentages of the growth. Species which at one time were seldom found in pure stands now occur in large bodies. These changes wrought by civilization have so upset the natural balance of nature, which if left unhampered eventually brings about stability and the survival of the fittest, that insect pests repeatedly gain the ascendancy and wipe out entire forest areas. No one factor so influences the rise and fall in abundance of an insect pest as the food supply of that particular insect.

GREAT EPIDEMICS

Bark beetles such as the southern pine beetle, the Engleman spruce beetle, and the Black Hills beetle; defoliators such as spruce budworm and the larch sawfly have repeatedly destroyed merchantable timber over thousands of square miles of territory. Never in the history of forestry has such tremendous damage been done to the forests of the Northeast as that which has just taken place following widespread outbreaks of the spruce budworm. During the last ten years over ten times as much timber has been destroyed in the Maine Forestry District by insects as has been destroyed by fire. The loss to our forests and forest products in the United States, not including injury to shade trees, amounts to several hundred millions of dollars a year. It is a serious situation and yet comparatively little effort is being made to meet it.

[1] Paper given before the Society of American Foresters, Boston, Mass., Dec. 29, 1922.

ENTOMOLOGY IN CONNECTION WITH INVESTMENTS

A thorough knowledge of forest insects and their relation to the forest is destined to play an important role in the future investments and management of timber lands. History has shown that certain specific types of forest growth are very susceptible to insect attack and are therefore risky long time investments. Take for example types such as the balsam, larch, locust, or even oak. It is rarely that these escape serious injury or death from insects. Already buyers are taking these factors into consideration before investing as is shown by numerous inquiries received in Maine this last year. Particularly is this true of the soft-wood types. Under certain conditions, though, even these types may be fairly immune.

ENTOMOLOGY IN CONNECTION WITH MANAGEMENT

It is particularly in connection with management that a knowledge of the principal forest insects, their habits, and methods of preventing outbreaks, is essential to the continuation of our forests. Lumber and pulp operations should be planned in the future with the following points in view. First, to stamp our incipient insect outbreaks by cutting in these locations. Second, to leave the forest in such a condition that the succeeding crop will be more resistent to insect attack than the present one. In short to cull out all undesirable and over-mature trees and to bring the forest back to a mixed hardwood softwood type wherever possible. Whether this condition can best be brought about by diameter limit cutting, or by other methods of cutting such as the shelterwood, strip, or seed tree systems, will have to be decided by the forester on the area. Some set method is particularly desirable in connection with the regeneration of pine on cut over pine areas where the new pine crop must first go through a serious weeding out due to the ravages of the pales weevil and later be confronted with an almost inevitable attack from the white pine weevil. Third, the harvesting of timber killed by fire, windfall, or insects, before the host of injurious flat-headed and round-headed borers ruin the timber entirely for lumber purposes. This is an extremely important factor in our pine and spruce regions today. Summer operations are particularly subject to loss from borers. Until some satisfactory method of piling or spraying of logs to keep them free from insect attack is evolved, control must

depend entirely upon the placing of the logs in water, or the rapid utilization of them, which means that the choppers and sawyers must work in unison. Under some conditions the removal of the bark is advisable on material that will not be injured by checking.

ENTOMOLOGY IN CONNECTION WITH NURSERIES AND PLANTATIONS

Insect pests often play an important part in the success or failure of forest nurseries and plantations. White grubs frequently destroy entire seed or transplant beds unless preventive measures are used. Experiments are now being carried on with the use of crude white arsenic which give every promise of success. Other forest nursery pests are the strawberry crown girdler which recently caused a loss of $15,000 in one State nursery, and the pales weevil which has ruined several forest nurseries which were located closed to cut-over pine areas. Work carried on by the Harvard Forest School has shown that weevil injury in plantations can largely be overcome by keeping up the density of the stand. In a like manner mound building ants, which frequently destroy large numbers of trees are easily destroyed, and economically so in plantations, by the use of carbon bisulfid.

ENTOMOLOGY IN CONNECTION WITH FOREST PRODUCTS

Injury to forest products such as seeds, construction timbers, tan bark, log cabins, etc., while not so closely allied with the general forester's work nevertheless comes under the jurisdiction of many of them. Whenever possible bark should be removed from the lumber and some method of piling used that will provide for the rapid drying out of the lumber. Powder post beetles often do a great deal of damage to seasoned products. Sap wood material is particularly subject to injury. A yearly inspection of material in store houses is advisable. Oftentimes millions of dollars can be saved with little or no cost through a simple adjustment in methods of utilization. Logs for cabins and rustic work should be cut during the late fall and utilized or piled at once so as to provide for the rapid drying out of the inner bark. Posts, ties, mine props, and similar products should, whenever possible, be treated with preservatives. Insects often pave the way for decay.

NEED FOR MORE WORK IN FOREST ENTOMOLOGY

Great advances have been made in the protection of forests from fire, but foresters have for some reason been slow about taking pre-

cautions against insect attack. This is due, I believe, largely because insect outbreaks are not spectacular and that the damage is often done before their presence is realized by the average person going through the woods. I believe the time has come when those interested in timber lands, will think twice before they will allow widespread epidemics to sweep their lands. An insect outbreak is very much like a fire in that it starts in a small area and, if left unchecked, spreads rapidly over large areas. The time to fight an insect outbreak is not after the damage has been done, but immediately that an incipient outbreak is located. Everything depends on preparedness. It is time that the word "control" be dropped and the word "prevention" substituted, for there is no more excuse for widespread insect outbreaks than there is for the forest fire. Both can be prevented. Already methods of forest management are under way and it is highly important that as complete a knowledge as possible of forest insects be available for consideration in formulating future methods of management. Particularly in connection with working plans would a knowledge of forest insects prove of great value. To date much of the work in forest entomology has either been along systematic lines or in connection with shade tree insects and is not applicable to forest conditions. This has been due largely to the fact that few forest entomologists have had any training or experience in forestry and have been unable to look at forest entomological problems from a practical forestry standpoint.

SUITABILITY OF VARIOUS AMERICAN WOODS FOR PULP AND PAPER MAKING

By Rudolph H. Grabow

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In discussing the suitability of various woods for paper pulp, it must be borne in mind that a narrow classification is impossible. One cannot say that paper made from spruce is always stronger than paper made from fir, for the cooking conditions may have been such that the fiber of spruce has been weakened very materially. Again, one would not be justified in saying that hemlock pulp is superior to that made from pines, although it may be true in many cases. So then, in trying to point out how pulps compare with each other we must consider factors such as ease of pulping, manner of making the sheet, and the use to which the paper is to be put.

We shall first consider some of the requirements which different kinds of paper must meet[1] and then consider the adaptability of the pulp from the various species for the different kinds of paper. In determining the suitability of these pulps, various factors must be considered, such as yields, fiber lengths, pitch content, ease of bleaching, ease of pulping, color, strength, and general appearance of sheet formed. Coniferous woods will first be discussed, then the hardwoods.

For a good printing paper the color and glare should be such as will not tire the eyes in reading. It should have a smooth surface and be free from fuzz so as to prevent blurring or "picking" in the process of printing. The filler or coating should be of a minimum amount so that the strength will not be impaired nor cause excessive wear on the type of plates. The paper must be carefully sized; soft enough to permit penetration, but resistant enough to prevent blotting. In rapid printing, where there is danger of "setting off" by printing on the back of the next page, or "lifting" of the surface due to soft sizing and viscous inks, which are to be guarded against, sizing is of great importance. Where permanent records are desired the paper should not be too bulky, should be free from organic material, which may

[1] F. P. Veitch, Report 89, U. S. Dept. of Agriculture; R. W. Sindall, Paper Technology; and Edward A. Dawe, Paper and its Use.

serve as food for fungi, and from acids and alkalis. The acids cause deterioration of the cellulose and form a good medium for bacteria growth. The pulp to be used for this grade of paper should consist of two types—one long-fibered for strength, and the other short-fibered and opaque to give smoothness to the surface, and sufficient bulk and opacity. The color should be white with as little of the yellow shade as possible, and the fiber should be soft and pliable so as to form a well-felted sheet free from fuzz. For lithographing and other high-class printing papers, rags and sulphite pulp from coniferous wood make up the long fibers, while soda or sulphite pulps from deciduous woods, or reclaimed book and magazine stock, make up the short-fibered stock. For newsprint, mechanical pulp from spruce, hemlock, or jack pine, and sulphite pulp from spruce or hemlock are used in a mixture.

Wrapping paper should, first of all, be strong and pliable, so that it will not break in bending, or be easily punctured in handling. It need not necessarily be durable, since most of the paper is used but once. The color does not have to be white, and may even be brown, but it should be uniform. The paper should be resistant to moisture, a quality acquired by sizing, which may be favored by cooking conditions. A long-fibered, strong and pliable stock is desirable, and sulphate pulp from the pines, tamarack, and Douglas fir answers the purpose well.

For blotting and filter papers, the main requirement is a porous, open structure which will insure good absorption. Filter papers should be free from earths, minerals, and ash residues, in view of the fact that they may be burned with the deposits on them for chemical tests. The pores should be uniform and not too large; otherwise, the residues to be retained will pass through. Soda pulp produces porous pulp, and that obtained from pine and mixed with aspen is adapted to this use.

Antiques are bulky, open-textured papers, commonly used for the more exclusive magazines, where an artistic appearance is desirable. Here, too, soda pulp containing a mixture of long and short-fibered stock produces the best results. Oftentimes rag stock is mixed with the wood pulp.

Having considered the qualities desired in the various kinds of paper, we should explain what is meant by different terms in describing the qualities of the wood and how these have been derived.

The fiber lengths are averages based on all the available data from Forest Service investigations and other sources. Many of the measurements given are the averages of hundreds of determinations; in others of only a few.

The yield in per cent is based on the bone-dry weight of the wood as obtained from experimental pulping on a semi-commercial basis under conditions which approximate those in commercial practice. The wood has been barked, and knots and undesirable material rejected.

The bleaching tests were made on a small scale, by stirring the pulps with varying amounts of bleach solution until the bleach was exhausted and making hand sheets after washing. These sheets were then compared with a standard sheet of sulphite and those comparing most favorably were chosen in estimating the amount of bleach required.

The basis of strength is derived from the various tests conducted at the Forest Products Laboratory, including the breaking length, pop test, folding tests, and thickness of sheet. Here again, not one factor but all the factors were used to secure a comparison, so that paper meeting all the requirements with good results were given preference over those which were high in some, but low in others. The pitch or resin in woods makes pulping by means of the sulphite process difficult, since sulphite liquor does not dissolve the resin nor permit even penetration into the wood by the cooking liquor. In making the sheet troubles arise from the clogging of the wire with pitch, causing uneven formation and frequent breaks.

CONIFEROUS WOODS

The coniferous woods will now be considered by genera. The order of importance into which the conifers may be put is as follows: Spruce, fir, hemlock, pine, Douglas fir, larches or tamarack, cedars (including Port Orford, incense, western red, white, and red), redwood, and cypress. In the order of importance we must consider the available supply, the amount of waste wood from other wood-using industries, the ease of pulping, the nature of the sheet produced, the minimum amount of bleach required to secure a maximum degree of whiteness, and the adaptability of the paper to different uses.

In the spruces we find the ideal wood for paper making. It pulps easily by all processes, is comparatively free from resin, and gives a good, light-colored, unbleached sheet which can easily be bleached to a very white color. In the laboratory experiments the minimum

amount of bleach required for black spruce sulphite pulp was 8 pounds of 35 per cent available chlorine per 100 pounds of bone-dry pulp, and the maximum was 30 pounds for white spruce sulphite. Soda and sulphate spruce pulps require 20 to 25 pounds of bleaching powder (containing 35 per cent available chlorine) per 100 pounds of bone-dry pulp to secure a good color. The fiber lengths vary from 2.8 mm. in blue spruce to 3.7 mm. in red spruce. The fineness of the fibers and the quality of the pulp obtained make the spruces the most desirable of pulp woods, and all species of the genus are eminently suitable for pulp-making by any of the processes. The yields of pulp decrease with the severity of the cook, but the average yield of all the spruces by the sulphite method is around 45 per cent on the bone-dry basis; for sulphate the yield is 50 per cent; and for mechanical pulp the yield is almost 90 per cent. Mechanical pulp from the spruces gives a good, strong, clean sheet, free from shives, and in these respects, all the species are very similar in character. The chief use to which it is put is for newsprint, for which about 75 per cent of ground wood pulp (usually white spruce) is mixed with 25 per cent of unbleached sulphite pulp. The sulphite gives it the necessary strength to run through high speed rotary presses. Spruce is usually considered the standard for comparing pulp and paper made from other woods by the sulphite process. It will also serve that purpose in this article.

Next in the order of importance are the firs, commonly called balsam (*Abies*). The chief species used is the balsam fir (*Abies balsamea*); the other firs are very similar in character. The pulping of the wood can be readily accomplished by all three processes. The yield is fully as good as that of white spruce. The fiber lengths are, in general, a little greater than for white spruce. The pitch content is not a hindrance, and the general texture, appearance, and handling are very nearly as good as in the case of white spruce. Bleaching of sulphite pulp can be accomplished by amounts which vary from 15 to 25 pounds of bleaching powder (35 per cent available chlorine) per 100 pounds bone-dry pulp, about 25 pounds for sulphate, and as much as 36 pounds for grand fir (*Abies grandis*) soda pulp. The uses for the pulp are much the same as for spruce pulp, some of the chief ones being newsprint, book paper, fiber boards, and strong wrapping paper. The susceptibility of the firs to decay, however, is a serious handicap to storage, and the firs are considered less desirable for this reason.

The next genus to be discussed is hemlock, of which the eastern hemlock (*Tsuga canadensis*), North Carolina hemlock (*Tsuga caro-*

liniana), and western hemlock are most widely used. All the species of this genus are very similar in character among themselves and somewhat more difficult to pulp and bleach, and not so desirable in general appearance. The yields compare favorably with those of spruce, being about 43 per cent for sulphite, 48 per cent for sulphate, and 85 per cent for mechanical pulp. Fiber lengths are 2.7 mm. to 3 mm. in length, thus forming a sheet with strength comparing favorably with that from spruce. The pitch content is not very large, so there is no difficulty in the sheet formation due to clogging of the wire. The bleaching can be done by using slightly more than is required by spruce, but 17 to 25 pounds of bleaching powder for sulphite pulp containing 35 per cent available chlorine gives excellent results. The pulp may be put to the same use as spruce and is frequently substituted for it in newsprint. Western hemlock is much more easily pulped than the other members of the genus, and would be extensively used if it occurred near the pulp-making centers.

In the pines we have a great many species which offer a large source of wood pulp. Some of these species were, until quite recently, thought not to be usable because of the high content of pitch. Most of the pines are difficult to pulp by the sulphite process and those that are fairly readily pulped offer difficulties in bleaching to a good grade of color. In general, where pines are pulped by the sulphite process the pulp is "shivey." This is due to bundles of fibers which are not completely disintegrated into the ultimate fiber, and this incomplete disintegration is probably due to the relatively large amounts of resins which prevent uniform and easy penetration of the chemical. Although there is some pine pulp produced by the sulphite process which can be used for a cheaper grade of newsprint or for grades in which a white color is not essential, the best pulp is obtained by the soda and sulphate processes. The ones which are hard to bleach may be used for natural colored wrapping paper, for cream-colored manila, or for similar uses. The easy bleaching stocks yield good grades of pulp as substitutes for bleached spruce sulphite used in book paper, and some of the pines are used for soda pulp in making the inferior grades of blotting paper. Mechanical pulp, especially jack pine (*Pinus divaricata*), yields a pulp comparing favorably with spruce for cheap newsprint. Recent experiments have shown that the southern pines (*Pinus taeda, Pinus echinata, Pinus palustris*), can be pulped by the sulphate process, and will give a good yield that will bleach to a high degree

of whiteness, so that it may be used for book paper. In an article [2] entitled "Book Paper from Southern Pines and Gums," it is pointed out that loblolly pine (*Pinus taeda*) and red gum (*Liquidambar styraciflua*) can be pulped by the sulphate process and bleached to a satisfactory color, suitable for book paper. By the sulphate process yields of from 35 to 40 per cent of pulp can be obtained. By maintaining a high efficiency in the recovery department of the pulping plant and by bleaching in two steps, this process will, undoubtedly, soon become commercially feasible on a very large scale. This will mean that a large amount of spruce pulp which is now being used for book paper will be replaced by pine pulp, thus making more sulphite spruce available for newsprint.

In the term southern pines are included shortleaf (*Pinus echinata*), loblolly (*Pinus taeda*), longleaf (*Pinus palustris*), Cuban (*Pinus caribaea*), scrub (*Pinus virginiana*), and pitch (*Pinus rigida*). Their structure and pulping qualities are very similar to each other. The pitch content of these species is high, so that they cannot easily be utilized for mechanical pulp. The yields are approximately 40 per cent for the sulphate process, with a bleach requirement varying from 18 to 35 pounds bleaching powder (35 per cent available chlorine) per 100 pounds of bone-dry pulp. It must always be remembered that bleaching depends upon cooking conditions. The length of the fiber is considerably above the average, that of loblolly being 3 mm., and of longleaf and shortleaf 3.7 mm.

The others of the more suitable pines, which offer opportunity for the utilization of waste are, white (*Pinus strobus*), Norway (*Pinus resinosa*), western yellow (*Pinus ponderosa*), sugar (*Pinus lambertiana*), lodgepole (*Pinus contorta*), and jack (*Pinus divaricata*) which has already been referred to. The pulping of this last named group is very much like that of the southern pines mentioned above. The value of these species for lumber (except jack pine and lodgepole pine) makes it doubtful whether the woods will be used for pulp. A considerable portion of the waste in saw and planing mills, however, could be so utilized. The bleach required in this last group of pines was slightly less than that of the southern pines. The sheet formed compared favorably with that of the southern pines in general appearance and strength, but was not quite as strong as that obtained from the spruces, even though the sheet is thicker and heavier. The fiber

[2] The Southern Lumberman, December 25, 1920.

lengths are shorter on the average than those of the southern pines, except white pine which has a fiber length of 3.8 mm., and sugar pine, with an unusually long fiber of 4.1 mm. These last two named pines also produce a sheet which is fully as strong as paper made from spruce. The use of the pine pulp is mainly for wrapping paper, although some of the more easily bleached pulps are utilized for book paper. Soda pulp from pine is frequently mixed with soda pulp from aspen in the manufacture of blotting paper from which filter boards are made.

Douglas fir (*Pseudotsuga taxifolia*) is suitable only for a good grade of "kraft" pulp for wrapping paper. Because of its pitch content it is unsuitable for the making of mechanical pulp. It is also hard to pulp by the sulphite process and still more difficult to bleach. The sulphate process is best adapted to the making of strong, dark brown wrapping paper from this species. The yield of crude pulp on the bone-dry basis is 41 per cent. Although the fiber is especially long (4.4 mm.), the paper is not as strong as that made from spruce pulp. The pulp cannot be bleached except by using such a large amount of bleach as to make it impractical commercially. Besides wrapping paper, the pulp may be utilized in making fiber board.

Tamarack (*Larix americana*) and western larch (*Larix occidentalis*) have been pulped, but the pulps are exceedingly difficult to bleach. The yield is about 45 per cent on the bone-dry basis for crude sulphate pulp. A good grade of kraft wrapping paper may be made from it. The fiber is 2.6 mm. in length and makes up well in the sheet formation. The strength compares well with that of white spruce.

The cedars include western red (*Thuja plicata*), Port Orford (*Chamæcyparis lawsoniana*), red (*Juniperus virginiana*), white or arborvitae (*Thuja occidentalis*), incense (*Libocedrus decurrens*). All of these species are extremely difficult to pulp by the sulphite process, but by the sulphate process good pulp can be secured, which is, however, difficult to bleach with reasonable amounts of bleaching powder. The main use is for making brown wrapping paper. Heavy sheets made from red cedar are sometimes used to put under carpets. It is claimed that the odor keeps away moths and other insects. Of the cedars, western red gives the strongest sheet. The yield of crude pulp based on the bone-dry weight is around 39 per cent. The fiber lengths were available only for incense (2.0 mm.) and Port Orford (3.6 mm.). Comparative strength tests show that western red and incense cedars

form a stronger sheet of paper than red cedar. Strength tests for Port Orford cedar are not yet available. Incense cedar, with its short fiber, makes a sheet stronger than western red cedar whose fiber is comparatively long. We cannot, therefore, say that the longest fibered wood will produce the strongest pulp, for there are other factors which influence the strength of the sheet. This is particularly true of redwood (*Sequoia sempervirens*).

Redwood fibers are 4.8 mm. in length, being the longest fibered coniferous wood; but the fiber is very tender and gives a sheet much weaker than one would expect. By the sulphite process a dark pulp, which is hard to bleach, is produced. By the sulphate process pulp is produced of about the same quality as that from Douglas fir. Experiments with the bark of redwood have been conducted, but the yield is poor, the quantity of chemicals required is very high, and the quality of pulp is very poor; so that at the present time it would not be feasible commercially to produce pulp from the bark by chemical means. The dark color, which is difficult to get rid of, is caused by a secretion in the life process of the parenchyma cells. Because of the large proportion of these cells compared to the other fibers it is hard to get a complete disintegration of the fiber bundles without overcooking some of them. The yield is, therefore, not very high.

The last genus of conifers to be considered is bald cypress (*Taxodium distichum*). This wood is difficult to pulp either by the sulphite or the sulphate process, owing, in part, to the high oil and pitch content. The fiber length is 3.3 mm., but here again, we find that the sheet produced is not as strong as one would expect. The fiber itself is soft and weak. Although a high yield of crude pulp was obtained by all of the processes, there were many "shives" in the pulp indicating incomplete disintegration under normal cooking conditions. The color of the sheet is dark and cannot be bleached to a good white unless exorbitant amounts of bleach are used. This pulp could be used for heavy bags, for it would be pliable enough to overcome breaking from repeated folding. Wrapping paper of a fair quality could also be made from it.

HARDWOODS OR BROADLEAVED TREES

In the manufacture of pulp and paper from the broadleaved trees, more commonly called hardwoods, we have a very marked difference in the length of fibers, which are much shorter and, in many cases, finer and wider than those of the coniferous woods. As already stated, the average length of the spruce fibers is about 3 mm., while those of the

hardwoods average less than 1.5 mm. Since the length of the fiber determines to some extent the strength of the sheet, we would expect paper made from hardwoods to be weaker than paper made from conifers, and this is true. Not all of the hardwoods will be included in this article, and some which are included are not used for paper making on a commercial scale because they have a greater value for other uses. They have a general interest, however, because of the possibility of using the waste from wood-working industries using hardwoods.

The genera to be included and the order of importance, which is based mainly on the amount of wood used as reported by the Forest Service, are as follows: Poplar, aspens, and cottonwood (*Populus*); yellow poplar or tuliptree (*Liriodendron*); gums (*Liquidambar* and *Nyssa*); birch (*Betula*); chestnut (*Castanea*); maple (*Acer*); sycamore (*Platanus*); basswood (*Tilia*); willow (*Salix*); and elm (*Ulmus*). The following genera are not listed according to the amounts of wood used, for the information has not been compiled: Catalpa (*Catalpa*); ash (*Fraxinus*); beech (*Fagus*); hickory (*Hicoria*); butternut (*Juglans*); oak (*Quercus*); cucumber tree (*Magnolia*); mangrove (*Rhizophora*); cabbage palmetto (*Sabal*).

Because aspen is considered the ideal wood for soda pulp, it will be used as a basis for comparing the other woods. Aspen can be reduced to pulp fairly readily by the mechanical and sulphite processes, and yields a good colored pulp; but by far the most of it is pulped by the soda process. This is true of the other poplars as well. Although fairly tenacious, the pulps are usually soft and bulky. The softness of the pulp may be due to the fact that its natural resin content is normally very low. The average fiber length of aspen soda pulp is 0.99 mm. The cottonwood fibers are somewhat longer, averaging 1.3 mm. Yields of the soda pulp vary from 41 per cent to 50 per cent of crude pulp on the bone-dry basis of the wood used. The amount of bleach required for well-cooked pulp is very low—8 to 20 pounds bleaching powder (35 per cent available chlorine) per 100 pounds of bone-dry pulp. The use to which the pulp is put in the bleached form is for book, magazine, antique, coated, lithograph, map, card, cover, common envelope, and wood blotting papers. In the making of these papers longer fibered pulp, such as bleached rag or long-fibered sulphite wood pulps, are mixed in various proportions. The long-fibered stock gives strength to the sheet, and the soda pulp of aspen gives bulk and opacity, so that the main purpose of the soda pulp is for filler.

Yellow poplar is an even-grained wood which is easily pulped by the sulphite and sulphate processes, but the pulp obtained from the sulphite process is harder to bleach to a good white color than that obtained by the sulphate process. The pitch content is very low, so there is no difficulty from that cause. The fiber is longer than that of aspen, the average being 1.4 mm. The yields obtained ranged from 44 to 45 per cent of crude pulp on the bone-dry weight of the wood. The fiber has good sheet-forming qualities, making a uniform, even-textured sheet, and one that is very free from shives, because the wood is readily pulped. The pulp obtained from the sulphate process can be bleached with less bleaching powder than that required for the sulphite and soda pulp. Ten to twenty pounds of bleaching powder (35 per cent available chlorine) per 100 pounds of bone-dry pulp gave excellent results. This pulp is used for a filler with longer-fibered stock for the making of book, magazine, or catalogue papers. It possesses sufficient strength, however, to be used without sulphite.

In the group of gums are included red (*Liquidambar styraciflua*); tupelo (*Nyssa aquatica*), and black (*Nyssa sylvatica*). These woods pulp best with the sulphate process, and yield a pulp which can be bleached to a good degree of whiteness without using excessive amounts of bleach—red gum and black gum bleaching more easily than tupelo gum. The yields of soda pulp is around 35 per cent and for sulphate 40 to 45 per cent crude pulp. When pulped by the sulphite process the bleach required to yield white pulp is extremely high. This group of trees yields pulp with fibers which are above the average for hardwoods in length, being 1.68 mm. for black gum, 1.55 mm. for red gum, and 1.85 mm. for tupelo gum. In the case of red gum, with a two-step bleach (that is by bleaching partly with a small amount of bleaching powder, washing the pulp, and then using another portion of bleach), pulps of good color were obtained by using 15 to 25 pounds of bleaching powder (35 per cent available chlorine) per 100 pounds of bone-dry pulp. In preliminary experiments, there is reason to believe that black gum and tupelo gum will do the same. By mixing the pulp from the gums with pulp obtained from southern pines by the sulphate process, excellent results have been obtained for the making of very good book paper.

The genus *Betula* has two species which have been pulped—white or paper birch (*Betula papyrifera*) and yellow birch (*Betula lutea*). Of these, paper birch is the more important. In the barking of the wood

difficulty is experienced because of the fibrous nature of the bark. Mechanical pulp is used for filler in the cheaper grades of paper. With sulphite the pulp obtained can be bleached by using 15 to 18 pounds of bleaching powder (35 per cent of available chlorine) per 100 pounds of bone-dry pulp, and for soda and sulphate pulp 20 pounds of bleach are required. The fiber of the pulp is 1.17 mm. in length, but not very strong; so that here, too, the main use of the pulp is in mixture with long-fibered material to give bulk and capacity to the sheet. The yield obtained in the case of the sulphite process was 39 per cent; for sulphate 43 per cent; for soda 37 per cent, and for mechanical pulp 90 per cent. Sulphate pulps from yellow birch are remarkable for their great strength in spite of short fiber. Unbleached sheets of this pulp made on the laboratory paper machine tested as high as average tests on high grade kraft.

The genus *Castanea* (chestnut) brings a new problem which we have not met with in the other species; that is the large amount of tannin which the wood contains. This must first be extracted so that the wood can be pulped, for the tanning compounds formed destroy the fittings in the digesters, and cause such a dark colored pulp as to make bleaching impossible for commercial practice. At one time, in a few of the pulp mills in the East, enough chestnut wood was used to make the extract a by-product, resulting in a decrease in the price of tannin extract. The fiber is short, 0.79 mm., soft, and not of good strength. For a while one of the Eastern paper companies supplied the Federal Government with postal cards made of chestnut soda pulp. The other uses are for book paper and other print papers when mixed with long-fibered stock.

Sugar maple (*Acer saccharum*) pulps well by the sulphite process, yielding a good, light-colored pulp which bleached by using 18 pounds of bleaching powder (35 per cent available chlorine) per 100 pounds of bone-dry pulp. The pulp is short-fibered and the sheet formed is very weak. The yield of pulp on the bone-dry basis of the wood was 47 per cent. The main use to which the pulp could be put would be as a filler with long-fibered stock for book and magazine paper.

Sycamore (*Platanus*) pulps by the sulphite and soda processes readily. The sulphite pulp required 18 pounds of bleaching powder (35 per cent available chlorine) per 100 pounds of bone-dry pulp; and the soda pulp 25 pounds to yield a white sheet. The fiber is about as long as that of the gums, 1.56 mm., but the pulp is not very strong. The yield of

soda pulp is 40 per cent and of sulphite 46 per cent. The pulp could be substituted for soda pulp from aspen.

Basswood (*Tilia*), as pulped by the soda process, yields 43 per cent crude pulp on the bone-dry basis of the wood. It bleaches easily, the pulp being soft and short-fibered (1.1 mm.), and can be substituted for aspen soda pulp.

In the willows we have wood that pulps readily by all processes. Sulphite cooks made on red willow yielded pulps of good color, which could be bleached to a high degree of whiteness by using 7 to 18 pounds of bleaching powder per 100 pounds of bone-dry pulp, depending upon the cooking conditions. The fiber is short but makes excellent filler with longer-fibered stock. Soda pulp required 27 pounds of bleach, and sulphate pulp 20 pounds of bleach per 100 pounds of bone-dry pulp. The yield was 49 per cent of crude soda pulp, and 48 per cent of sulphate pulp. By increasing the severity of the cooking an easier bleaching pulp could be secured, but the yield would be decreased. The soda and sulphate pulps can be used for book and magazine paper, or wherever bulk and opacity are desired.

The elms have three species which are used for pulp making. These are white elm, rock elm, and slippery elm. The fibers of the elms average about 1.3 mm., and produce soft, fairly light-colored pulp which bleaches quite easily. In the case of rock elm the yield for sulphite pulp was 40 per cent, sulphate and soda about 45 per cent. Sulphite pulp required 12 to 18 pounds of bleach, and soda and sulphate pulp required 20 pounds of bleach per 100 pounds of bone-dry pulp. The uses of the pulp are much the same as those of aspen, for which it can be substituted.

The following species are not used to any extent commercially, but as the information is available they are included: catalpa, ash, hickory, butternut, quercus, cucumber tree, mangrove, and cabbage palmetto. The yields average about 40 per cent of crude pulp on the bone-dry basis and the amount of bleaching required to produce a light-colored pulp is about 30 pounds (35 per cent available chlorine) per 100 pounds bone-dry weight of pulp, except butternut, which is extremely dark-colored and hard to bleach. In cabbage palmetto, the bleach required was about 30 pounds, but final cooks have not yet been completed. All these woods produce weak, short-fibered pulp, which could be substituted for aspen as filler with long-fibered stock for book and magazine papers.

CONCLUSIONS

In conclusion, we can say that for sulphite pulping the most important species are in the coniferous woods of low resin content, and for soda pulping, aspen and similar deciduous woods are the important commercial species. For mechanical pulp, spruce is used most, and balsam and hemlock rank next in order of importance. For sulphate pulp, both the coniferous and deciduous species are adapted, and will be used according to the uses contemplated.

For future production of wood pulp, species which have not generally been used, such as the maples, basswood, ash, and cucumber, offer possibilities for utilization of the waste from wood-using industries. It would, however, be necessary to have this waste available from enough mills to supply a pulp mill.

THE SUITABILITY OF WESTERN SPECIES FOR CROSS-TIES

By Ovid M. Butler

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During recent years the demand for information on the suitability of western species for cross-ties has increased very perceptibly. This is a natural consequence of a growing recognition of the fact that the railroads of the country are becoming more and more dependent upon western forests for their cross-ties. This fact was brought home to the railroads quite emphatically following the war when consumers of lumber were confronted with a temporary wood shortage. Many railroads, which heretofore had obtained ties from nearby sources, were suddenly forced to buy in the west. Throughout the central and eastern states, including parts of New England, cross-ties from the Pacific Coast became a new but not uncommon sight.

That the cross-tie fraternity is now in a more receptive mood than probably ever before to learn about the properties of western species is not without significance to the forester. The writer recalls very vididly many conferences with various railroad purchasing agents some six or eight years ago, when as a district representative of the Forest Service, he was conscientiously trying to advance the sale of National Forest stumpage. These conferences were invariably of the inconclusive, pro and con character. They were usually unsuccessful. The purchasing agents were well steeped in self-complacency of present practice and suavely adept in staring out of countenance such fragmentary evidence of a scientific character as the writer could bring to bear upon the properties of certain western species.

Today conditions are much changed. From the great amount of information which the Forest Products Laboratory has been able to assemble from many service test records, laboratory tests, and scientific studies of wood, it has been possible to classify within fairly accurate limits the many western species on the basis of their cross-tie values. It is the purpose of this paper to present a digest of the more important information bearing upon the suitability of western species for ties which the laboratory has gradually accumulated.

With very few exceptions, practically every commercial species is of some value as a cross-tie, but its relative value will be determined by its natural durability, its strength or mechanical properties, and its capacity for taking preservative treatment. Natural durability is, of course, a very decided advantage, but its absence can be overcome by preservative treatment. While some of the western species are naturally more durable than others, they all, with the exception of redwood and the cedars, fall into a class which may be termed nondurable because they require preservative treatment to give the most efficient service.

The fact that durability is controllable within certain limits makes the mechanical properties of a species of chief importance from a cross-tie standpoint. A nondurable species, for example, with high mechanical value, can be made durable by treatment, but a naturally durable species of low strength, although its life can be materially lengthened by the use of tie plates, cannot be materially strengthened.

Three points are of special importance in determining the mechanical suitability of wood for cross-ties: (1) its bending strength, or ability to resist ordinary strains due to center binding; (2) its strength in compression parallel to grain and end hardness, which are measures of its resistance to spike pulling and lateral pressure on spikes; and (3) its side hardness and compression perpendicular to grain, or its ability to resist rail or plate wear.

In classifying different species on the basis of their mechanical properties in relation to their cross-tie suitability, the laboratory has worked out composite values for each, thus making it possible to compare the western species with the more important and well established cross-tie woods, such as the oaks and the southern pines. These composite values are derived from many thousands of strength tests made by the Forest Service. The basis used in developing them is shown in Table 1.

In Table 2 are given the composite strength values for western species which have been selected as suitable for cross-tie use. Direct comparison is possible with a number of other species which are now, and have been for a long time, considered more or less standard cross-tie woods.

The table also includes specific gravity and some of the more important mechanical properties for each of the species, namely, compression perpendicular to grain, side hardness, specific gravity, and resistance to withdrawal of nails. The values shown for compression perpen-

TABLE 1.—*Basis for the Development of a Composite Strength Figure for Ties.*

Mechanical property	Relative weight used in forming composite figures	Relation of mechanical property to use of species for cross-ties
	Per cent	
Static bending—		These properties involve the strength when used as a beam. They are of primary value in determining the resistance offered to breaking caused by "center binding."
Modulus of rupture	14.3	
Fiber stress at elastic limit	7.1	
Impact bending—		
Fiber stress at elastic limit	7.1	
Total	28.5	
Compression parallel to grain—		These properties involve the resistance offered to a compressive force exerted lengthwise along the grain and are of value in indicating the resistance offered to lateral pressure on spikes.
Fiber stress at elastic limit	7.2	
Maximum crushing strength	14.3	
End hardness	10.0	
Total	31.5	
Side hardness	20.0	Indicates the resistance to rail wear, abrasion, etc.
Compression perpendicular to grain—		
Fiber stress at elastic limit	20.0	
Total	40.0	
Composite figure	100.0	

dicular to the grain and side hardness are especially significant, since they reflect important strength properties for cross-ties.

In view of the fact that density or specific gravity is a measure of the wood substance in the tree or timber, this value, it may be noted, might easily be used as a ready means of determining the mechanical suitability of different woods for cross-ties. It is a simple matter to determine the density of wood and it is the most ready method of roughly determining the relative strength value of a given species of timber.

With Table 2, it is possible to arrange the western species into several groups, classified on the basis of their mechanical values and compared with red and white oak and longleaf pine which, in any grouping of American species, will occupy Group 1. Group 2 will include western larch, Douglas fir (Coast), Port Orford cedar, and redwood which have the highest strength values of the western species listed. In Group

TABLE 2.—*Mechanical Properties of Various Species Based on Tests of Small Specimens Free from Defects.*

Species	Composite figure [a]	Specific gravity [b]	Compression perpendicular to grain [c]	Side hardness [c]	Resistance to withdrawal of nails
			Lbs. per sq. in.	*Lbs. per sq. in.*	*Per cent*
White oak	1,040	.59	830	1,060	100
Longleaf pine	965	.55	600	590	100
Red oak	[a]940	.56	730	950	100
Western larch	800	.48	560	450	.....
Douglas fir (coast)	795	.45	530	470	85
Port Orford cedar	730	.41	380	480	.....
Redwood	.....	.41	520	460	.....
Western hemlock	670	.38	350	430	.....
Douglas fir (mountain)	660	.40	450	400	.....
Red fir (magnifica)	622	.37	440	380	.....
Incense cedar	621	.35	460	390	.....
Grand fir	595	.37	340	360	.....
White fir	590	.35	440	330	52
Sitka spruce	590	.34	330	370	.....
Western white pine	585	39	300	330	.....
Lodgepole pine	560	.38	310	330	.....
Western yellow pine	555	.38	340	320	58
Sugar pine	555	.36	350	320	.....
Western red cedar	525	.31	310	260	.....
Alpine fir	470	.31	310	220	.....
Engelmann spruce	455	.31	290	240	49
Northern white cedar	415	.29	290	230	43

[a] The composite figure for red oak is low in comparison with that of longleaf pine on account of its comparatively low strength values in bending.
[b] Based on volume when green and weight when oven dried.
[c] Values for green material.

3 falls western hemlock, Douglas fir (mountain), red fir (magnifica), and incense cedar. The fourth group includes grand fir, white fir, Sitka spruce, and western white pine. The fifth group includes lodge-pole pine, western yellow pine, sugar pine, and western red cedar. The sixth group includes Alpine fir, Engelmann spruce, and northern white cedar.

It is perhaps well to call attention to the fact that the values given in Table 2 are average figures for individual species, and that the mechanical values of individual ties, or lots of ties, of any given species may vary as much as 30 per cent above or below the composite figure, depending upon the density and freedom from defects of the individual ties.

From its records of service tests of ties, which are probably the most complete and comprehensive in existence, supplemented by the judgment and opinions of railroad officials and the consideration of data from other sources, the laboratory has also been able to classify most of the western species on the basis of their durability when used either untreated or treated with zinc chloride or creosote. This classification is given below and must necessarily be considered an estimate, since more extensive and definite data from actual service tests are necessary to a final classification. This is especially true in the cases of species which have not been used in large amounts or for long enough periods to yield reliable service records.

TABLE 3.—*Estimated Average Durability of Western Ties.*[a]

	Untreated	Treated with 0.5 lb. zinc chloride per cu. ft.	Treated with 10 lbs. creosote per cu. ft.
	Years	*Years*	*Years*
Redwood	10-12	.....	.....
Port Orford cedar	10-12	.....	.....
Incense cedar	8-10	.....	.....
Western red cedar	7-9	.....	.....
Douglas fir	6-7	11	15
Western larch[b]	6-7	11	15
Western hemlock	5-6	11	15
Lodgepole pine	4-5	11	15
Western yellow pine	4-5	11	15
Spruce	3-4	8	10
White fir (*Abies concolor*)	3-4	8	11
White fir (*Abies grandis*)	3-4	8	11
Red fir (*Abies magnifica*)	3-4	8	11
Engelmann spruce	3-4	8	11
Alpine fir	3-4	7	11

[a] Based on use of tie plates on all treated ties and the assumpton that the ties are subject to heavy traffic.

[b] Used only in Montana, northern Idaho, and western Washington. Douglas fir ties in this region have about same average life as western larch.

The laboratory's test track data so far as they go indicate that the estimated durability given above is conservative. If based entirely on these data, for example, Douglas fir, western yellow pine, lodgepole pine, and western hemlock would be shown more durable than is estimated in Table 3.

Durability is, of course, a variable value influenced by many factors and combinations of factors. Sapwood is less durable than heartwood and therefore the presence of sapwood in a tie is an important factor

in the durability of the tie if untreated. In addition to the species and quality of the wood, the soil, climate, and conditions under which the tie is used are influential factors in its durability. Much is heard about the influence upon the durability of ties of the time or season of cutting. The laboratory has failed to find that the time of cutting has any appreciable effect upon the durability or other properties of the wood provided proper care is taken of it after cutting. The influence, in fact, appears to be in the method of handling ties during the season in which they are cut.

A few years ago railroad specifications quite generally required that ties be cut in the late fall and during the winter, but this requirement has now been largely eliminated. Some tie producers, however, still restrict their periods of cutting, especially among those where continuous transportation from woods to treating plant is not possible. They appear to figure that it is cheaper to restrict the cutting period than to develop proper methods of handling during seasons of the year when the ties are most subject to external influences.

Insects and spores of fungi are most active in the spring and early summer and ties cut during that period are consequently more subject to their attacks. During the hot weather of the summer, seasoning takes place rapidly and ties cut then are often subject to excessive checking unless properly piled and protected. It is thus apparent that the cutting of ties during the spring and summer months involves efficient, careful handling, which is a factor of expense, whereas if cut during the fall and winter seasons, seasoning takes place with much less checking and fungi and insects are not active. The old popular belief that the advantage of winter cutting is because the sap is down has no scientific basis. The moisture content of green wood in summer and in winter is practically the same.

Another popular belief upset by scientific studies is that seasoned, untreated timber is much more durable when placed in contact with the soil than green timber. The records of the laboratory do not show this to be the case. While moisture content is the principal factor influencing the rate of decay, the tie when placed in the track at once begins to lose or acquire moisture according to the conditions under which it is placed. In other words, the moisture content of timber quickly adjusts itself to surrounding conditions.

The information at the laboratory further indicates that fire-killed or dead timber which is sound and free from decay is as strong and

durable as green timber. In practice, the condemnation of dead timber for ties has unquestionably resulted from the fact that it often contains decay, some of which is difficult to detect. If carefully inspected, and unsound ties are eliminated, it is just as valuable and serviceable as live timber.

The third important consideration is the permeability of the species. As foresters well know, there are great differences in the ease and uniformity with which different species and, indeed, different pieces of the same species may be treated. No satisfactory explanation of why one species is more or less penetrable than another has yet been advanced. Methods of treatment best applicable to different species are therefore necessarily based on emperical methods. The variety of phenomena with which one is confronted in attempting to work out methods of treatment may be indicated from some of the statements in U. S. Department of Agriculture Bulletin 101 [1] which are based on experiments in treating conifers with creosote.

It was found that, with few exceptions, the summerwood of coniferous species was easier to penetrate with creosote than the springwood. In the pines the springwood penetrations were especially erratic. It was further observed that resistance to penetration in conifers was least in the last formed summer tracheids and greatest in first formed spring tracheids, although the latter have the thinnest walls and the largest cell cavities. The sapwood of Douglas fir, the larches, pines, spruces and redwoods was found to be more easily treated than the heartwood. In the hemlocks and the true firs there was little difference.

A knowledge of the manner in which a given species responds to preservative treatment is obviously of great importance from the standpoint of cross-tie utilization. Uniformity of treatment is essential to efficient service and the best treating practice recognizing the great variations in the resistance of different species to treatment, grades the ties on the basis of their ease of treatment.

With the exception of western yellow pine practically all of the western species suitable for cross-ties fall in the class of timber which is relatively difficult to treat. Sap southern yellow pine and western yellow pine represent a class which is probably most satisfactory from the wood preservers' standpoint. Radial and longitudinal penetration for both species averages high. As a group lodgepole pine, red and white fir, and Engelmann spruce are somewhat more difficult to treat

[1] Relative resistance of various conifers to injection with creosote.

than western yellow pine while Douglas fir, western hemlock, western larch, Sitka spruce, and Alpine fir are classed as species of still greater resistance, although they are all treated and are greatly benefited thereby.

The fact that these species are refractory to present methods of treatment does not condemn them, because it is only a question of time until further knowledge will make possible the working out of methods which will assure more effective treatment for each species. Many of these species are now being widely used for ties and are giving good results, but not as good as will be possible when the wood preserver has further developed and put into application the science of treating the species.

ESTIMATING THE CUT ON SMALL SALES OF GOVERNMENT TIMBER

New Methods of Estimating Compared to Actual Scale

By M. R. Brundage and J. R. Berry
U. S. Forest Service

Under the present Forest Service regulations payments for National Forest saw timber are always based on the scaled contents of all material cut by the purchaser. Every sawlog is individually measured and numbered and the merchantable value recorded opposite the same number in a scale book. All loss from cull material (rot, shake, pitch-seam, cat face, etc.) is deducted before the entry is made.

In the case of the larger operations, when the cut of Government timber is continuous, and averages 30,000 feet per day or greater, it is feasible for the Forest Service to employ one or more regular scalers and assign them permanently to a particular sale area, since the values at stake are large enough to warrant the salaries necessary for such permanent assignment.

The cost of scaling in these cases, when reduced to terms of "cents per thousand feet b. m." is small and the Forest Service has no intention of deviating from the method of actual scale when the expense of such procedure can be kept within reasonable limits.

SMALL OUTPUT AND SCATTERED TRACTS

There are other classes of sales, however, that have given rise to certain problems of administration and that have always been a source of extra scaling expense which the Forest Service cannot afford to sustain and which, from a strictly business standpoint, is entirely unwarranted.

These sales may be divided into two main heads:

1. Sales to the small operator whose daily cut runs anywhere from 5,000 to 20,000 feet per day.

2. Sales of a few scattered subdivisions of Government stumpage which occur as isolated 40, 80, or 120-acre tracts partially or entirely surrounded by private stumpage and which are usually applied for by

large operators to be logged in conjunction with their private lands.

Under the first class it is readily apparent that the employment of a competent scaler at a salary of $120 a month, to be assigned permanently to an operation cutting only 10,000 feet per day, for example, would result in the exorbitant cost of 50 cents per thousand feet for scaling alone. Even with 20,000 per day, the cost would still be out of proportion at 25 cents per thousand feet. It, therefore, has been found necessary to require the small operator to deck his logs in the woods or near the mill in such a manner that the scale may be taken once or twice a week, according to the volume of output. Scaling is then done periodically by one of the regular Forest personnel.

This method, of course, inconveniences the operator and puts him to an added expense of re-handling all logs. Again, during the season of greatest fire hazard—June, July, August, and September—when every member of the Forest personnel is sometimes badly needed for fire protection, it is often impossible to find a man available at certain specified periods and scaling must be postponed a day or two, resulting, at times, in an actual shut-down of the operator's mill because all the logs previously scaled have been sawed. Withal it is a very unsatisfactory method of scaling from the viewpoint of both the operator and the Forest Service.

Under the second class—sales of scattered subdivisions—a different set of complications occur. The areas under contract are practically always situated in such a way that it is difficult or impossible to log them economically as a unit, that is, the Government logs cannot be yarded to the landing, where scaling is done, in a separate and continuous lot. The topography may be such that only one corner of a Government forty can be reached from a given set-up, another portion from a second landing, and so on. Every change of line brings in part private and part Government timber, necessitating a special mark of identification on every Government log cut so that the scaler can distinguish the two lots at the point of scaling. Though the operator is yarding at the rate of 40,000 to 50,000 per day from any one side, the Government timber may form such a small proportion of this volume that the cost of scaling becomes excessive. Again, a period of several days, or even weeks, may elapse when private timber is being yarded exclusively. The scaler must be laid off, assigned to other work for which he is not fitted, or retained on the payroll as an unproductive employee so that he will be immediately available the minute the opera-

tor resumes activities on Government land. If the scaler is dismissed it is extremely difficult to hire another experienced man when needed in the middle or near the end of the logging season.

On small sales involving in the neighborhood of 200,000 feet, the alternative of scaling with calipers in the woods after the trees are felled, but before the logs have been pulled apart in yarding, has sometimes been employed. The bark must be cut to the sap on two sides or else estimated as to thickness, making it very difficult to get the true average diameter. It is impossible, of course, to see end defects such as center rot, pitch-seam, worm holes, etc., and cull must be estimated. All things considered it is probable that the method of caliper scaling is no more accurate than the 100 per cent estimate described below.

COMPARATIVE DATA IN SCALE AND ESTIMATE CALLED FOR.

To avoid the difficulties and prohibitive expense just described, one method stands out clearly as an ultimate solution of the problem, viz.: the method of selling by estimate only. The best way to determine the feasibility of such a proposition was to run a number of experiments on going sales, first making careful estimates and then comparing these with actual scale at the end of the season.

The results of one of these experiments are covered in detail by this article. The data were secured from a sale area in the yellow pine type conducted by a small operator who logged by means of horses and tractors. A circular mill was installed adjacent to the sale area, producing a daily cut of between 8,000 and 9,000 feet. Scaling was done once each week.

VOLUME TABLES.

The Forest Service, since its inception, has been constantly carrying on investigations and research and taking thousands of measurements of all species and sizes of timber for the purpose of constructing a set of volume tables which, when applied by experienced estimators will yield results very close to the actual scale by Decimal C rule of the trees estimated.

The latest and most highly developed tables are based on "site classes," the total heights of mature trees being considered as a reliable index of site, or timber producing capacity of any given area. Donald Bruce[1], of the University of California, in 1921, published such a set of tables for

white fir, a description of which appeared in a subsequent issue of *The Timberman*. The U. S. Forest Service, District 5 (California District), worked up a similar series for yellow pine, and still another set is being prepared for sugar pine.

The volume tables used in this experiment for sugar pine and incense cedar are the same that have been used by the Forest Service since 1911. These are not divided into site classes but nevertheless produced very satisfactory results.

METHODS USED IN ESTIMATING.

In all commercial sales of saw timber on National Forest areas every tree to be cut is blazed and stamped with the "US" brand. In conducting this study, every tree marked was carefully measured and the height, diameter, and species recorded. This gave a 100 per cent estimate for the entire area logged during the season. Two men worked together, one at the base of the tree, who did the actual marking and measured the breast-high diameters by means of a cruiser's stick or diameter tape, and the other, at a uniform distance of 100 feet from each tree marked, who estimated the merchantable height to the nearest 16-foot log, or actually measured the length by means of a hypsometer, and recorded all measurements in a note book.

These two measurements—diameter breast high in inches and total merchantable length by number of 16-foot logs—are all the data necessary for interpolating from the volume tables.

DEDUCTIONS FOR CULL AND BREAKAGE.

Two distinct methods were used in figuring cull and breakage. The relative accuracy of these systems is indicated in the accompanying tables.

Method No. 1 is purely an estimate based on the estimator's knowledge of the timber, his experience, and on cull and breakage figures obtained from the scale of other sale areas.

Method No. 2 was devised with the idea of eliminating guess work and is based on the supposition that the percentage of cull in sample logs taken at random from every part of an area will be an accurate index of the cull percentage of the whole. Under this system the following procedure is recommended: The Forest officer in charge of

[1] A White Fir Volume Table. Bulletin No. 329, University of California publication, August, 1921.

the sale will make inspection visits at least once each week while cutting is in progress. During each visit he will actually scale 15 to 20 logs, recording merchantable material and cull as separate items. Great care must be exercised in the selection of these sample logs. If the sample scaling is done at the mill the work should begin at one end of the deck (sample logs will not ordinarily be scaled at the mill when a pond is used for storage) and proceed *regularly* without any attempt at *individual* selection, that is, spotting logs here and there.

At the end of the season, then, the "Cull Percentage Book" will contain the merchantable and non-merchantable contents of from 600 to 1,000 logs of all species from every part of the cut-over area. Sound and cull material will then be added for each species and the percentage of cull calculated.

A certain amount of breakage is unavoidable, of course, and under Forest Service regulations the operator is permitted to leave all logs in the woods which do not come up to certain specifications governing merchantability. In this case, all *pine* logs were considered merchantable which were 10 feet or over in length, 10 inches or larger in diameter at the small end, and which contained not less than one-third of sound material after deducting for cull. The same specifications regarding length and diameter applied to cedar and fir, but logs of these two species could be left in the woods if more than one-half of the scaled contents was cull material. In regular scaling practice all logs below the specifications just given, if delivered to the point of scaling, are entered as total cull, the portion of merchantable material below 33⅓ per cent of the total scale for pines, or 50 per cent for fir and cedar, not being charged for. Broken pieces below the minimum length of 10 feet are recorded in the same manner.

If the sale is by estimate and cull is determined by the sample log method, all breakage and cull left on the area will be scaled in full and deducted from the original gross estimate. The remaining balance, therefore, will represent all material removed from the area. The cull percentage for each species from the sample scale book then will be applied directly to this balance and deducted, leaving the net estimate of merchantable material to be paid for by the operator.

COMPARISON OF ESTIMATE WITH SCALE.

Table 1 clearly shows the progressive steps followed in estimating, with a direct comparison between the volumes obtained by each method

TABLE 1.—*Comparison of Estimate with Actual Scale.*

			Y. P.	S. P.	I. C.	W. F.	Total all species
Gross volume, feet b.m.	A	Scaled	609,720	40,960	74,990	2,110	727,780
	B	Estimated	612,980	42,130	78,950	2,060	736,120
Volume unmechantable, feet b.m.	C	Left in woods	3,890	.....	1,800	.....	5,690
	D	Scaled at landing	9,860	550	40.0	.....	33,680
	E	Total cull by actual scale —(C+D)	13,750	550	23,270	.....	39,370
Method No. 1 (cull and breakage estimated)	F	Estimated per cent at time of marking	5.0	3.0	25,070	0.0	8.6
	G	Actual per cent—(E÷A)	2.26	1.34	33.4	0.0	5.4
Method No. 2 (Breakage and cull in woods (C) deducted. Balance of cull from sample logs.)	H	Gross est. volume removed (B—C) ft. b.m.	609,090	42,130	77,150	2,060	730,430
	I	Per cent cull from scale of sample logs. (Compare with J)	1.65	4.4	31.8	.....	4.99
	J	Per cent cull from scale of all logs at landing (D+(A—C))	1.63	1.34	31.8	.....	4.66
Net merchantable volumes, ft. b.m. Error expressed as per cent of true scale	K	Net merch. scale (A—E)	595,970	40,410	49,920	2,110	688,410
	L	Method No. 1 (B—(F×B))	582,330 (—2.3%)	40,870 (+1.14%)	47,370 (—5.1%)	2,060 (—2.4%)	672,630 (—2.29%)
	M	Method No. 2 ((B—C)—(I×H))	599,040 (+0.51%)	40,280 (—0.32%)	52,620 (+5.4%)	2,060 (—2.4%)	694,000 (+0.8%)

NOTE:—Under-estimate shown by —. Over-estimate shown by +.

of deducting for cull and breakage, and the volume obtained from actual scale.

It is common knowledge to those familiar with timber scaling that no two scalers, no matter how expert they may be, will obtain exactly the same results in scaling the same run of logs. If the two totals are within 2 per cent of each other, the scaling is considered satisfactory. If within the 1 per cent no closer results can be asked for, especially when one or two species show a high percentage of cull. On this basis, then, Method No. 1 is 2.29 per cent too low. This is usually the case when cull and breakage are estimated before the timber is cut as the majority of timber sale men have a tendency to cull too heavily rather than to be too conservative. In spite of this under estimate, however, it will be noted in Table 2 that the United States is still ahead of the game (compared to the cost of actual scaling) by 8 cents per thousand feet. In other words, the estimate may be appreciably lower than the results obtained in this experiment, and still the seller will not lose any *net* receipts.

Method No. 2, which in this case gave a net total only eight-tenths of one per cent higher than the actual scale, is so close that no objections can possibly be raised. It is doubtful if results would ever be *higher* than this. Other experiments in District 5 have shown estimates to be low rather than high.

BUYER AND SELLER BOTH SAVE MONEY.

Selling by estimate should invariably result in a net profit to both the buyer and seller of stumpage if the estimate is reasonably accurate. To determine the saving to the Forest Service in this experiment, records were kept of every item of expense for scaling and separate records for each method of estimating.

To determine the saving to the operator an estimate was made of the expense involved in pulling the logs apart in the woods after bucking so that the ends were in plain view for scaling. Since the timber was small one team of horses could handle most of the logs, though at times four horses were required. The estimated cost for this operation was $56. (This figure is probably lower than would have been obtained if an accurate record of labor cost, team hire, etc., had been kept, but the Forest officer in charge could not be on the ground every time the "pulling apart" took place, and the operator did not segre-

gate these costs from his general logging expense). This is a little better than 8 cents per thousand feet of merchantable cut.

Decking the logs at the mill for a week's run, or at loading points way, and the cost per thousand to the operator would have been appre- in the woods, would have been much better from the Forest Service standpoint, as the scaling could have been done at a lower cost and with greater efficiency, but the operator claimed he could not live up to such a requirement, so the method of scaling the logs at the point of falling and bucking was given a trial.

Decking at the mill would have necessitated some extra grading and construction work as well as special mechanical equipment or an extra team of horses for moving the logs from the deck to the carriage roll- ciably higher. Decking in the woods would also have exceeded 8 cents per thousand.

It is not probable that future small sales will be scaled under the system of pulling apart in the woods. In fact, due to the extra scaling expense and various difficulties inherent with this method, it will likely be abolished on the area covered by this experiment in favor of one of the other methods of decking. Hence it may be readily seen that the actual saving to the operator when a sale is made by estimate, will ordinarily be greater than the figures given in Table 2.

TABLE 2.—*Costs and Savings.*

	Merchantable volume, ft. b. m.	Total cost to Forest Service	Cost per M ft. b. m.	Saving or gain to U. S. due to selling by estimate		Saving to operator due to selling by estimate	
				Total	Per M ft. b. m.	Total	Per M ft. b. m.
Actual scale.....	688,410	$128.11	$.186	.....	.....	.....	.....
Method No. 1.....	672,630	34.60	.051	$55.92	$.083	$93.59	[a]$.136
Method No. 2.....	694,000	51.40	.074	86.08	.124	46.63	[a].068

[a] Based on actual scale.

NOTE.—The net difference in total stumpage values due to the estimate being less (Method 1) or greater (Method 2) than the actual scale was a loss to the U. S. of $37.59 in the first case and a gain of $9.37 in the second case. The loss to the seller is, of course, a gain to the buyer and vice versa. The saving to the buyer by method 1 is $37.59 plus the amount saved ($56) if he had been relieved of the cost of rehandling for scaling purposes. By Method 2 the buyer saves $56 *minus* $9.37.

When sales are made by estimate to donkey operators, the expense of logging the Government area as a separate unit, or the cost of marking all Government logs before yarding if private and Government timber are mixed, will be saved.

Though the administrative advantages to be gained through selling by estimate have been fully realized by Forest Service officials, the method has not been approved by the Forester because of the inaccuracy of the old volume tables and the difficulty of estimating cull and breakage. However, with the recently improved and refined volume tables, together with more accurate methods of figureing cull and the practice of actually scaling unmerchantable material left in the woods, the method bids fair to approach actual scaling in reliability and may be put into effect in the near future, under suitable regulations and restrictions, as part of regular timber sale procedure.

REFORESTATION BY COAL COMPANIES IN SOUTHWESTERN PENNSYLVANIA[1]

By Walter D. Ludwig
District Forester, Johnstown, Pa.

The area which will be considered as southwestern Pennsylvania in this paper roughly includes that portion of the State bounded by a line drawn through Pittsburgh eastward through Johnstown to the top of the Allegheny Mountains and then southward along the top of these mountains to the Maryland line and has an area of about 6,000 square miles. Within this area, with Pittsburgh as the center, is the greatest and most important bituminous coal field in the eastern United States and this, combined with the great industries of all kinds, particularly iron and steel, makes such a peculiar condition as to make this section unique among eastern centers of population.

While there is constant need of timber and timber products of all kinds to keep alive the great industrial activity of the region, yet the largest portion of such requirements is for the mining industries, and this paper will deal particularly with the needs of such industries in this section.

NEED FOR REFORESTATION

During 1922 the author made a study of the industrial timber requirements for this section and found that it required about 1 billion board feet per annum. Of this amount about one-half is needed for the wood-using industries, while the remainder represents the rough timber used such as mine and railroad ties, mine timbers, poles, posts and other material. For the mines themselves, it is safe to assume that they will require about one-third of the total amount, or approximately 300 million board feet per annum.

For this section, the author determined further that the present timberlands were producing only about one-tenth of the annual requirements, leaving nine-tenths of the supply to be shipped in from other points. It is significant in this connection that the "yellow pine group" made up one-quarter of the material shipped into the region to take

[1] Read before the Pennsylvania Section of the Society of American Foresters, February 23, 1923.

care of its industries and each year this proportion is becoming larger as the scarcity of native timber becomes more acute.

At the same time, it was shown that the present area of 1,000,000 acres of woodlands now suitable for forestry purposes must be continued as forest land, as well as steps taken to care for the more than 400,000 acres of present brush land and the reforestation of about 300,000 acres of abandoned farm land in order to make the region self-supporting in the matter of its timber requirements and that this might be brought about within the next 25 years through proper and intensive management.

Keeping these facts in mind, it will be seen that the coal industries in the region will have to take care of all their present holdings of timberlands, as well as start to reforest about 100,000 acres of abandoned farm land if they are to have a local supply of their own timber for their operations

In addition, nothing has been considered in this paper as to the necessity of reforestation for the protection of watersheds and streams and in no section of Pennsylvania is there greater and more pressing need of such work than in this region. Because of the intensive local requirements for mining purposes, the forests generally have been devasted and stripped down to the smallest prop and stick, often less than three inches in diameter and in most cases no provision being made for natural regeneration or artificial reforestation. With railroads penetrating everywhere to supply the mines, forest fires have resulted and added to the general depletion of the forests and water supply.

PLANTING WORK DONE

Since 1916, careful and accurate records are available as to the number of seedlings planted for reforestation purposes by the coal and coke companies in this region and it is safe to assume that before that period the amount of this work done may be disregarded entirely. From that time and including the work contemplated during the spring of 1923, the records show that these companies planted on an average of only about 200,000 to 300,000 seedlings per annum, which, spaced about 5 by 5 feet apart, will cover from 120 to 170 acres per annum. As noted previously in this paper, it will be necessary to reforest 100,000 acres within 25 years to make these companies self-supporting in timber, which will require that 4,000 acres of abandoned farm land be planted up each year and the records show that about one-thirtieth of this amount is being planted.

That this work on the part of these companies is only starting cannot be denied and it is indeed gratifying that each year the coal and coke companies are realizing the necessity for it to save themselves from the increasing cost of operation through the shipment of timber from the South and the Pacific Coast. Of the approximately 1,000,000 seedlings which will be planted this spring in the region, it is a fact that at least three-quarters of them will be set by these companies and industries.

Some of the larger companies have realized the necessity of this work years ago, and in this connection I cannot refrain from mentioning the efforts of the Cambria Mining & Manufacturing Co. of Portage, which maintains its own nursery; the Clearfield Bituminous Coal Corporation of Indiana; the Eastern Bituminous Coal Mining Bonds of Frugality; the Bethlehem Mines Corporation of Heilwood; the Homer City Coal Co. of Johnstown; the Vinton Colliery Co. of Vintondale; the Rich Hill Coal Co. of Hastings; the Arrow Coal Mining Co. of Pittsburgh; the Pittsburgh Coal Co. of Pittsburgh; the Graceton Coke Co. of Graceton; the Berwind-White Coal Mining Co. of Windber and others which have taken up the work in a lesser degree throughout the region.

OBSTACLES ENCOUNTERED

In view of the great necessity of reforestation work on the part of the coal and coke companies in the region and the apparent slowness and reluctance of such companies to take up the work extensively and in a business-like manner characteristic of such industries, it may be well to inquire into the causes for such an attitude and to endeavor to make plain some of the misunderstandings and errors. In considering this phase of the matter, I am certain that the causative factors may be classified into three or four reasons and I shall treat each of these briefly.

(1) The majority of the operators are unwilling to wait over the period of time required for the planted trees to mature so that they may use them in the coal mining operations. Only the larger operators have sufficient coal in sight to last them more than 10 to 15 years and what acreage is available is being taken over rapidly by these large companies.

(2) It is difficult for the average operator to see the wisdom of obtaining only a small percent of interest on his investment covering a period of years necessary for the maturing of the planted trees. At

the same time, he cannot or will not see that, after the planted areas start to yield, he will be securing his mine timber for a small fraction of what it cost him before and that he is truly making a large return on the original investment.

(3) Many of the operators own little land in fee and have secured title to the mineral rights only so that they are not interested in replanting land over which they have no control or interest. At the same time, where such companies do own farm land they find from bitter experience that they can obtain no profit from leasing it for agricultural purposes; that the persons renting the farms have no real interest in them only to the extent of taking off everything and returning nothing for the permanent improvement of the soil, so that there is a general apathy and unconcern as to the future of such lands. The result is that more so-called poor farm land is being abandoned each year, so much so that it is a serious question from the agricultural standpoint alone.

(4) Probably the main reason for this apparent lack of interest on the part of the operators lies in the failure of the planted trees to thrive and often fail because of planting species entirely unsuited to the site. I cannot emphasize this point too much because I have noted instances where large companies have become entirely disgusted and thoroughly unwilling to do any further planting work. Generally, coal and coke operations require the planting of a tree which will furnish them some returns in the way of props and ties of small size within say 25 years. At the same time, the soil generally over the coal regions is not the best and after being depleted through poor farming it is much worse; while there is a notable lack of moisture due largely to the lowering of the water table to the level of the coal or mine.

For these reasons, a hardy species having a comparatively short rotation should be recommended and from experience I can vouch for the following species for this work: Scotch and Austrian pine, pitch pine, red pine, banks pine, and the Japanese black and red pines. All of these species have been tried out in the region and are meeting with all expectations, as well as furnishing the type of wood necessary for mining operations.

I would caution against the recommendation of planting hardwoods at all, and especially catalpa, it being entirely unsuited for the purpose in this region. What hardwoods are needed can be obtained in the

future from the existing timberlands which consist almost entirely of these species. Oaks, once considered almost indispensable for mine cars and certain construction work, are being replaced successfully by the all-steel mine car and the conifers from the South and the Pacific Coast. Species which are in any way particular as to the site quality should not be recommended unless they have been tried out on an experimental plot. I realize that from time to time certain species will be introduced which promise something good, but I would first try these out on the sites through experimental plantings, and if proven satisfactory, they can be used in the permanent work.

Considering all factors, I believe that considerable more interest can be created throughout the region among the coal and coke companies in reforestation work, and I am certain that in time they will take the same business-like view of such work as they do now of any portion of their operations. The operator is, in the last analysis, a business man and when he sees the business side of reforestation he will take it up as keenly as he does the mining operation.

THE RAILROAD FIRE[1]

By Ralph C. Hawley

In the brief time allotted, the subject cannot be treated fully. The intention is to emphasize certain aspects of the problem. The writer has had to deal with the forest fire problem both as an owner and as a manager of forest properties which, in common with others, have suffered and are in frequent danger of suffering from fires caused by various agencies. He has also had experience as an appraiser of forest fire damage due to fires originating from railroads. Hence the viewpoint from which this article is written is that of the practicing forester, rather than that of the state official.

It is common knowledge that in the United States steam railroads are one of the principal causes of forest fires. The relative importance of this cause varies in different parts of the country. Railroad fires as a cause reach maximum importance in the region along the Atlantic Coast, which includes Rhode Island, New Jersey, Connecticut, Massachusetts, and that part of New York State lying adjacent to and between the three latter states.[2] Approximately 15,000,000 people or 14½ per cent of the total population of the United States live here in an area of less than 17,000,000 acres. This is at the rate of 591 inhabitants per square mile.

The region in addition to being the most densely populated territory of its size on the American continent contains a high percentage of forest soils and after several centuries of settlement is still more than forty per cent wooded. To serve this population there has been developed a network of railroad lines and a transportation service unequalled elsewhere. The combination of a well wooded region with intensive railroad development creates an enormous railroad fire hazard. Statistics indicate that this region has a higher percentage of railroad fires as compared to those originating from other causes than any other part

[1] Delivered before the annual meeting of the Society at Boston, December 29, 1922.

[2] This territory might be enlarged to include portions of Pennsylvania, Delaware, and Maryland. In fact for Pennsylvania as a whole railroad fires from 1915-1921 inclusive formed 33 per cent of the total number.

of the country. The annual average percentage for the region is estimated at 33 per cent as contrasted to about 15 per cent for the United States as a whole.

For the purposes of this article further statistics will be confined to the State of Connecticut which lies in the middle of the region just described. Only two railroads operate within this State and hence it was easier to secure the desired statistics. All statistics used are for the State of Connecticut unless otherwise stated.

Over a five-year period, 1917 to 1921, inclusive, the records of the State forester indicate that in Connecticut 37 per cent of the forest fires are caused by railroads. The railroad fires burned over approximately 33,000 acres as against 97,000 acres traversed by fires due to other causes. Hence the railroad fires amounted to 26 per cent of the acreage burned over. What the statistics do not bring out is the fact that the railroad fires burn usually in comparatively fixed zones adjacent to the right of way. In exceptional seasons of danger fires may advance over previously unburned areas. It is estimated that at least 90 per cent of the railroad fires each year are on lands previously burned over. Only in exceptional seasons or in unusually large fires do the railroad fires run over new territory.

The unfortunate thing about the situation is not that railroad fires form as much as 37 per cent in number of all forest fires but that they do not form 100 per cent. There are two reasons why it would be desirable to have railroad fires constitute 100 per cent of all forest fires:

First. Because the railroad is the only agency which comes anywhere near paying for the losses caused by the fires set.

Second. Because when the three parties interested in the problem, namely, the State, the railroads and the owners adjoining the right of way, all cooperate intelligently, railroads as a cause of forest fires can be eliminated.

According to the law, all costs of fighting railroad fires must be paid by the railroads. In other words, the railroads pay 100 per cent of the costs of fighting the fires for which they are responsible. Contrast this with the facts regarding fires set by other causes. During 1917 to 1921 only 1.9 per cent of the costs of fighting forest fires originating from causes other than railroads were paid by the agencies responsible for setting the fires.

TABLE 1.—*Forest Fire Statistics for Connecticut for the 5-year Period 1917 to 1921, Inclusive.*

	1917	1918	1919	1920	1921	Total	Per cent
Number of fires set by railroad	486	365	235	151	225	1,462	37
Number of fires due to other causes	607	663	475	257	473	2,475	63
Total number of fires	1,093	1,028	710	408	698	3,937	100
Damages—R. R. fires	$42,734.20	$25,162.75	$19,979.50	$17,266.00	$33,496.50	$138,639.05	31
Damages—other causes	87,290.05	100,801.25	57,950.00	23,186.50	39,889.50	309,117.30	69
Total damages	$130,024.25	$125,964.00	$77,929.50	$40,452.50	$73,386.00	$447,756.25	100
Cost of fighting R. R. fires	$3,551.08	$2,475.75	$1,445.53	$1,034.80	$1,742.68	$10,249.84	28
Cost of fighting fires from other causes—							
Paid by private agencies	59.00	370.90	84.45	91.95	139.80	746.10	72
Paid by public agencies	9,647.41	11,015.54	8,225.13	3,350.87	6,081.79	38,320.74	
Total cost of fighting fires	$13,257.49	$13,862.19	$9,755.11	$4,477.62	$7,964.27	$49,316.68	100
Acres burned over by R. R. fires	12,216	7,149	4,893	3,643	5,522	33,423	26
Acres burned over by other causes	27,683	27,561	19,238	7,705	14,974	97,161	74
Total acres burned over	39,899	34,710	24,131	11,348	20,496	130,584	100

In the period 1918[3] to 1921, inclusive, the railroads paid in forest fire claims $107,504.15. The damage estimated by the State as due to railroad fires in the same period was $95,904.75. On the basis of estimated damage 112 per cent of the loss was paid. W. O. Filley, formerly State Forester of Connecticut, estimates that not over a dozen cases a year occur in which damages are paid by other parties responsible for fires. This would amount to between two and three per cent of the number of fires set by causes other than railroads.

Since damage caused by railroad fires is paid for in large part and that caused by other fires is rarely collectible, should not State organizations direct their efforts first and primarily to the elimination of causes other than railroads and to the control of fires set by such causes?[4] Provided the railroads in your territory are paying only a small fraction of the damage caused by their fires this suggestion may not be valid. It is believed that in portions of the region considered a higher percentage of the loss from fire is paid by the railroads than elsewhere in the United States. The claim departments in some cases already recognize the idea of expectation value of young stands.

In those sections of the country where railroads are not as yet paying the full value of the loss a responsibility devolves on the forester to educate the people to ask for and to help them get full damages. In southern New England at least that period has passed and the average owner is apt to ask for more than the full value of the loss.

The fire risk is recognized as one of the principal obstacles to the practice of forestry. But this is not true where the chief fire danger is from railroad fires. One of the safest and most desirable places to practice forestry is in the zone adjacent to railroad lines. For here, in addition to having a location close to transportation lines the forest owner is furnished free gratis by financially responsible corporations what amounts to fire insurance on his property. Forest owners should not be dissuaded from practicing intensive forestry on lands close to railroads. Intensive forestry includes protection of the forest crop. A fire protection plan should be made for and applied on each tract by the owner as an important part of the forest work. Owners should keep

[3] It was impossible to obtain statistics of damages paid prior to the year 1918.

[4] Entire cessation of effort on the part of state organizations to prevent and extinguish railroad fires is not advocated—particularly as the cost of such work is relatively inexpensive. But, while other fire causes remain prominent, let the chief attention be turned in their direction.

records of their expenditures and will then be in position to collect full damages in case fires occur.

The railroads eventually through electrification of their lines or through the use of other fuels than coal may eliminate fires. It is believed that with spark arresting devices in proper condition even coal burning locomotives as a cause of fires may be reduced to a fraction of their present importance. Even with inefficient or defective spark arresting equipment, the use of fire lines parallel to the railroad in conjunction with keeping the right of way free of inflammable material and patrol over the most dangerous sections will bring the damage down to a small part of the present figures.

Why is it that the railroads have not as a whole adopted these measures in a systematic way? The relative newness and insignificance of the forest fire problem in the minds of the controlling officials, and their belief that the payment of damages is cheaper than prevention of the fires constitute the chief reasons. Foresters have got to educate the public and through them the men who govern the railroads before the latter will cooperate fully to prevent railroad fires.

The railroad right of way is in most cases not wide enough to serve as an effective fire line. Here the adjoining owners should maintain fire lines on their own lands. Fires will rarely get beyond properly constructed and maintained railroad fire lines supplemented by a fire line on private land.

Since a railroad fire may start on an unprotected private tract and spread thence to other property it is essential that in a wooded section all owners adjoining the railroad track maintain fire lines. The State should step in here and accomplish the mintenance of such lines either by persuasion or by legal measures.

In the past the relation of State organizations to railroad fires has been along the line of enforcement of the special laws relating to such fires. Their efforts might advantageously be directed to a greater extent than at present toward educating the higher railroad officials in the importance of fire prevention and in attaining the active cooperation of all interested land owners in securing protection against railroad fires.

NOTES ON WOOD DECAY—I.[1] THE WOOD DESTROYING PROPERTIES OF POLYPORUS VOLVATUS

By Henry Schmitz

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In a recent note[2] the writer reported some observations concerning the occurrence and probable parasitic nature of *Polyporus volvatus* Peck. It was also pointed out that this fungus was usually considered to be of very little importance both from the point of view of its probable parasitic nature and from the point of view of its wood-destroying properties. The present note deals with the latter phase of this question.

In general the same procedure was followed in this work as has been previously employed in this laboratory when the wood-destroying properties of a fungi are studied. Small blocks of the various woods, approximately 1 inch by 1 inch by 3 inches, of known weight were placed in two quart Mason jars to which about a 2-inch layer of apple wood sawdust had been previously added. After the addition of a sufficient amount of distilled water, to thoroughly moisten the sawdust and blocks, the flasks and contents were sterilized at 15 pounds pressure for 30 minutes. After cooling, the culture flasks were inoculated with *Polyporus volvatus* and the cotton plugs covered with a sheet of paraffined paper. The incubation period was 5 months at 28° C. After the incubation period the blocks were removed from the culture flasks, dried to constant weight at 102° C. and again weighed. The difference in weight between the first and second weighing, minus the loss in weight shown by the uninoculated controls, indicates the amount of decay that had occurred.

The results, which are the average of five sample blocks, are recorded in Table 1. The maximum loss in weight shown by any one of the blocks is also given.

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[1] Several years ago this laboratory committed itself to the policy of designating all of its publications dealing with the decay of wood in its broadest sense, "Studies in Wood Decay." From time to time notes have also been published dealing with some particular phase of wood decay but which were not comprehensive enough to be designated by the above caption. It is now proposed, in addition to "Studies in Wood Decay," to inaugurate a series under the common title of "Notes on Wood Decay," of which the present note is No. 1.

[2] Schmitz, Henry. Note concerning the decay of western yellow pine slash caused by *Polyporus volvatus* Peck. Phytopath, 12:494-496, 1922.

TABLE 1.—*Amount of Decay of Several Coniferous Woods Caused by Polyporus Volvatus Pk.*

	Average loss in weight per cent	Maximum loss in weight per cent
Larix occidentalis	3.5	3.8
Picea engelmanni	14.0	19.3
Pseudotsuga taxifolia	2.3	7.4
Pinus ponderosa	1.0	1.1
Pinus ponderosa (sapwood)[a]	2.4	2.6
Pinus monticola (sapwood)	1.1	1.7
Tsuga heterophylla	1.6	2.2
Abies grandis	11.7	17.3

[a] This culture jar was contaminated with Aspergillus.

The results indicate that *Polyporus volvatus* is at least able to cause serious decay of Engelmann spruce and white fir. In these two cases the wood became quite soft and friable. It should be remembered that 5 months is a comparatively short incubation period for this type of work, and since *Polyporus volvatus* grows rather slowly, the maximum loss in weight exhibited by any one test block is perhaps a better indication of the amount of decay produced by this organism than the average loss in weight as shown by all the test blocks, especially when the incubation period is relatively short. This is due to the fact that when a culture flask is inoculated with a slow-growing organism, it takes some time for the mycelium to spread from the inoculum to all the blocks in the culture flask.

The results obtained with spruce are also interesting in light of the fact that some years ago von Schrenk[3] reported that *Polyporus volvatus* often destroyed the sapwood of the northeastern spruces in a few months, especially where it followed the attack of Dendroctonus.

It is regretted that the culture flask containing blocks of western yellow pine sapwood became contaminated, thus making these results of no comparative value. In this region, *Polyporus volvatus,* although occurring on other species, is very common on western yellow pine.

In the case of western hemlock blocks, although the average loss in weight was low, several blocks had quite large decayed cavities at the ends of the blocks.

The data here presented, although meagre, are sufficient to indicate that *Polyporus volvatus* may cause fairly rapid and important decay of at least Engelmann spruce, white fir, and Douglas fir, and also that it decays other species of wood to a greater or less extent.

[3] von Schrenk, H. Some diseases of New England conifers. A preliminary report. U. S. Dept. of Agri., Div. of Veg. Phys. and Path. Bulletin 25:1-56, pl. 1-12, 1910

THE CONTROL OF MISTLETOE BY PRUNING.

By James R. Weir.

The article by Perry in the October (1922) number of this Journal on the eradication of mistletoe [1] on young conifers by cutting out the infected branches is of considerable interest. This method has been practiced in a small way to eliminate mistletoe [2] on yellow pine shade trees in Spokane, Washington. In the environs of this city this parasite is very abundant on all age classes and causes disfiguration of young trees left in yards for ornamental purposes. Property owners whose trees were not surmounted by taller infected trees and who following the writer's suggestions cut out all branches bearing colonies of mistletoe and those showing swellings, a characteristic early stage of infection, reported that the parasite had not with a few exceptions reappeared 3 years after the pruning. By cutting out the later infections their trees appeared to be entirely free from the parasite.

It seems that this method could be applied as has been practiced in some foreign countries to forest areas where the value of the tree would merit such intensive control and in the course of a few years free definitely prescribed areas of the parasite. The following conditions will necessarily have to be considered:

The parasite fruits from seed infection in from 3 to 5 years. Later prunings must precede maturity of the plant.

The aerial parts of the plant are easily seen from the time of first emergence through the cortex and is usually preceded by a swelling at the point of infection. Branches bearing such swellings should also be pruned.

Infection at the junction of two branches should cause the removal of both branches.

Trees with infections on the main stem should be removed. It is definitely known that such trees soon become girdled and are greatly retarded. The infection spreads up and down the stem and the mistletoe plants will of course produce seed.

All misshapen and suppressed infected trees should be cut down.

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[1] *Razoumofskya cryptopoda* (Engelm.) Coville (*Arcenthobium robustum* Engelm. nomen nudum) (Intermountain yellow pine mistletoe).

[2] *R. campylopoda* (Engl.) Piper (Pacific slope yellow pine mistletoe).

The method is of value only on areas of more or less uniform reproduction of a size that can be pruned from the ground and with no overtopping infected trees of the original stand within a distance of 300 feet or more. This does not allow for the transportation of seeds by animals and birds which is a negligible factor and by wind which at present is not believed to be of great importance.

Extending sale operations over areas of infection whereby the cutting or pruning of infected trees whether merchantable or not for the protection of seedlings growing as an understory is to be considered whenever possible. This should be done before any great amount of reproduction develops on the area.

The parasite on tall trees of the original stand will be able to project seeds farther on the down hill side of steep slopes than from the same height on level areas.

The danger of infection to the individuals of a mixed stand by different species of mistletoe has been determined by inoculation and will be published in a separate paper.

Pruning should not be done when the seeds of the parasite are mature for the reason that the seeds will be expelled more widely. The yellow pine mistletoe matures its seeds in late summer, varying with the latitude and elevation.

Both pistillate and staminate plants should be pruned.

Pruning wounds on trees of the age classes here considered are rarely infected by fungi.

ROOT ROT AS A FACTOR IN SURVIVAL

By Ferdinand W. Haasis

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Last January the second thinning was made in two white pine sample plots in the Biltmore Plantations. During an examination in May in company with Dr. Hedgcock of the Bureau of Plant Industry it was observed that one tree in each of these sample plots had been uprooted. In both cases the roots were found to be infested with a yellowish-brown stringy rot which Dr. Hedgcock identified as pine root fomes (*Fomes annosus*). Apparently the fungus weakened the roots so that they broke during some exceptionally windy period. The Asheville office of the Weather Bureau has in fact recorded exceptionally high winds on three days this spring. These occurred in March, April, and May and varied in velocity from 30 to 44 miles per hour. This station is located from 3 to 6 miles distant from the sample plots. The thinning of course opened up the stand to such an extent that the trees were more easily windthrown than would be the case in unthinned stands with their crowded crowns.

Dr. Hedgcock in discussing the seriousness of this rot commented that the thinning would result in a certain amount of drying out of the soil and this in turn would form conditions less favorable for the spread of the fungus. The fungus is said to be very apt to spread from tree to tree by means of roots in contact. It has been described as occurring on most conifers but much more rarely on hardwoods.[1]

Here is a situation which suggests many interesting possibilities. As Dr. Hedgcock pointed out, some such factor as this could very readily cause many blanks in a wild pine stand and thus leave the way open for such a mixture of pines and hardwoods as occurs in the Southern Appalachians. It may even be that some of our observations of tolerance and suppression could much better be interpreted in terms of root-rotting fungi than in terms of light needs. A detailed study of some of these more obscure relations would undoubtedly yield results of direct applicability in our silviculture practice.

[1] Cf. Rankin, W. H. "Manual of Tree Diseases." 1918.

PRELIMINARY NOTES ON STUDIES OF TREE FORM

By C. Edward Behre.

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For the past few years the writer has been interested in studying the application of the Swedish Form Class methods of timber estimating to American species, with the idea of determining whether the universal character of the volume and taper tables based on form classes constructed by Professor Tor Jonson and in general use by the Swedish Forest Service for many years, would not be of great service in working out problems of growth and yield in this country. It is thought that this work would be of special value in studying the development of second-growth stands and the stimulated growth after partial cuttings, both of which problems are complicated by changes in form which make existing volume tables of doubtful accuracy.

In 1903, A. G. Höjer (*1*) developed from measurements of Norway spruce an empirical formula to express the diameter of a tree at any point on its stem. This formula has the form $\frac{d}{D} = C \log \frac{c+1}{c}$ in which "d" is the diameter at distance "1" from the tip, "D" is the diameter at breast height and "C" and "c" are constants.

In 1910 (*2*) and 1911 (*3*) Tor Jonson, working with this formula, showed its close conformity to the actual tapers of forest trees and used it as a basis for computing taper tables and also tables of cubic contents of trees of all sizes, which, based upon the theory that trees of all species are built in the same manner in accordance with the mechanical stress to which they are subjected, should prove applicable to any species. Jonson, however, in comparing the values given by Höjer's formula with the actual tapers of Scotch pine, noted a considerable falling off in the tops, which he attempted to correct by the introduction of a so-called "biologic constant" in the original equation, making it read $\frac{d}{D} = C \log \frac{c+1-2.5}{c}$ for Scotch pine. In spite of this failure of Scotch pine to conform exactly to the original equation, Jonson decided that the deviation was not so serious but that the original volume tables would be sufficiently accurate for this species as well as Norway spruce.

L. Mattsson (*4*) studied the form of European and Russian larch in great detail, finding their form practically identical and differing scarcely any from that of Scotch pine as worked out by Jonson. However, the upper diameters of the tall trees in the larger form classes showed a similar falling off, to which Mattsson did not seem to attach much importance in drawing curves for an average series.

On this side of the Atlantic the tapers of eastern white pine, red pine, white spruce, Douglas fir, western white pine and a few other species were given some study by H. Claughton-Wallin and F. McVicker in Ontario and British Columbia (*5*). For the eastern white and red pines a falling off in the tops even greater than that of Scotch pine was noted, probably because of rapid height growth of the young trees measured. However, the conclusion that eastern white pine and Norway pine conformed quite closely to the form of Scotch pine was reached. The work on the western species was limited in extent and all the trees were grouped together into one average series after elimination of the distortion of the breast high diameter by root swelling. Jonson's volume tables have also been used in practical work in eastern Canada by H. R. Wickenden (*6*) with apparent satisfaction.

Many European investigators have studied the possibility of expressing the form of trees by a mathematical formula, but until Höjer's work, the previous workers had all attempted to use the equation of some known solid of revolution as the paraboloid, cone, neiloid or some intermediate form, to express the tapers of forest trees. Sven Petrini (*7*) has shown that this cannot be done because the portion of the stem within the crown conforms to a different type of solid of revolution than that below the crown. Höjer, however, approached the problem in an analytical manner, and by the use of integral calculus, evolved his equation to fit the empirical values based on actual tree measurements.

The present investigation is based upon detailed measurements of almost 200 western yellow pines of from 4 inches to 44 inches d. b. h. and from 30 years in age to overmaturity. Diameter measurements were taken at every tenth of the height from breast height to the tip. It was found that the root swell began to be noticeable in even some of the smallest trees, and so each tree was plotted and the distortion of d. b. h. eliminated graphically. The root swell increases gradually with size, not exceeding 3 per cent of the d. b. h. for trees less than 22 inches, but reaching 8.5 per cent in trees 40 inches d. b. h. This is consistent

with the results obtained by Petrini (*7*) for Lappland pine and Mattsson (*4*) for European larch, although the latter made root swell a factor of height rather than diameter. A study of the bark thickness shows that below 16 inches d. b. h. the bark is about 14. 4 per cent of the breast height diameter but that the ratio falls off gradually with increasing size, being 14.2 per cent for 20-inch trees, 13 per cent for 30-inch trees and 12.3 per cent for 40-inch trees. Further study of the influence of site, age and mixture upon bark thickness and root swell is needed, although these factors do not seem to have a very consistent effect.

With the root swelling eliminated as indicated and a "normal" d. i. b. at breast height determined, the trees were grouped into "normal" form classes and the average per cent of tapers at each tenth of height above breast height determined for comparison with Höjer's formula. The comparison brought out two important facts. First, for the lower form classes the conformity with the formula was very good, and second, that for the higher form classes the falling off in the upper diameters noted by Jonson for Scotch pine and by Claughton-Wallin and McVicker for eastern white and red pines was very much greater.

Following Jonson's "biologic constant" idea, it was found that this constant would have to be increased to 7.5 at least to get conformity for form class 80 and that when this was done the conformity in the lower form classes was entirely destroyed, the figures for the lower portions of the stem being exaggerated and those for the upper diameters not being large enough. Furthermore, the inconsistency of the equation when the "biologic constant" is introduced was so greatly exaggerated that it could no longer be overlooked. This inconsistency lies in the fact that with the "biologic constant" the equation gives no diameter to that proportion of the top of the tree represented by this constant. For small values like 2.5 per cent this is not serious, but the curve becomes entirely imcompatible with nature if the value must be increased as high as 7.5 per cent. Furthermore, the "biologic constant" makes a practically uniform reduction in the upper diameters of all form classes while the variations noted in nature are confined to the higher form classes.

Referring to Johnson's original data for Norway spruce (*2*) it was found that even in these measurements there was a slight falling off in the upper diameters of the large form classes and so it seemed apparent that the Höjer formula gave a form whose upper diameters were

greater than those of any species for which measurements are available. With this in mind, an analytic study of the western yellow pine data was made to determine whether Höjer's equation could not be modified by the introduction of a new term to better fit the conditions, or if a different equation could not be found which would more nearly strike the average form of all the species, rather than a super-maximum as represented by the Höjer equation.

As a result of this investigation, a new equation for the stem curve is presented which seems to be much more consistent in its conformity to nature and at the same time to give values intermediate between the maximum and minimum series of the different species so far investigated. This equation has the form of the ordinary hyperbola, $y = \frac{x}{a + bx}$ or expressed in terms similar to Höjer's equation, $\frac{d}{D} = \frac{1}{a + bl}$. Conformity to this equation is indicated by a plot of the values of $\frac{x}{y}$ x, producing a straight line.

Solving this formula for the constants "a" and "b" yields the following taper series and absolute form factors.

Form class	Per cent of d. i. b. at breast height at									Absolute form factor
	90	80	70	60	50	40	30	20	10	
	Per cent of length from tip to breast height									
55	91.7	83.1	74.0	64.7	55.0	44.9	34.4	23.4	11.9	0.369
60	93.1	85.8	77.8	69.3	60.0	50.0	39.1	27.3	14.3	0.404
65	94.4	88.1	81.2	73.5	65.0	55.3	44.3	31.6	17.1	0.442
70	95.5	90.3	84.5	77.7	70.0	60.9	50.1	36.9	20.6	0.483
75	96.5	92.3	87.5	81.9	75.0	66.7	56.3	42.9	25.0	0.528
80	97.3	94.1	90.4	85.8	80.0	72.8	63.2	50.0	30.8	0.580

The best method of plotting in order to study the variation between the different formulae and the actual tapers of the different species is to plot diameter expressed in per cent of d. b. h. as ordinates with form class as abscissae, a separate curve being shown for the values at each tenth of the stem above breast height. This method permits of accurate interpolation to any desired form class and therefore of rapid and better comparison of the conformity of two or more species, the

actual average of whose tapers may all fall in slightly different form classes.

The measurements available for Norway spruce (*2*), Scotch pine (*3*), European and Russian Larch (*4*), eastern white pine (*5*), red pine (*5*), white spruce (*5*), Douglas fir (*5*), western white pine (*5*), and western yellow pine, when charted and compared in this way demonstrate that the new equation evolved by this study gives a more consistent universal expression of form than either Höjer's original formula or any modification of that formula by the use of the "biologic constant."

It is proposed to work up taper and volume tables based on the equation presented herewith and to publish them with the detailed results of this investigation when its various phases have been completed.

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ESSENTIALS OF MANAGEMENT PLANS

Comment by Burt P. Kirkland

It is to be feared that the article on management plans, by John F. Preston and I. S. Eldridge, on page 116 of the February issue of the Journal of Forestry, if unchallenged may give American foresters an undeserved reputation for a universal lack of adaptation to their job. It appears that the authors of this article have made the mistake of assuming that it has taken as long for all foresters to become cognizant of suitable principles of working plans formation as in their own case. This assumption can, I think, be shown to be quite incorrect, as it is possible to bring from Forest Service files working plans prepared prior to 1912 of just as great simplicity and equally workable as any being prepared today. Moreover, these plans were not for entire forests but for producing units capable of producing 30 to 50 million feet b. m. annually on a sustained yield basis. It can be further stated that before that time there was adequate publication in the Journal dealing with the matter of the size of working circle in which the water shed or producing unit contributary to a single community or residential area was, I believe, set forth as the proper management unit. It is true that certain foresters did advocate national forests, or even regional units, and it is a sign of great progress of the Forest Service that these large units have definitely been given up.

It is further apparent that the authors are in grave danger of attempting to bring about a fixation of the methods which they now espouse which will be equally dangerous and inflexible bars to future progress in that line as the methods which in some instances were advocated and used some ten years ago. For example, abandonment of a contour map as a "pure luxury" is a step which puts us back before even the first beginnings of proper methods of forest survey in this country. At a time when over half the lumber industry of the Pacific Coast realizes that the expenditure of a cent or two per thousand feet in making a good contour map can save oftentimes from 50 cents to a dollar per thousand feet through proper location of lines of transport, how can any forester now justify the abandonment of a contour map? As a matter of fact there is no cheaper map that will convey any information worth while concerning rough areas,

such as most of the forest areas of the west are. The use of hachures is a time consuming, antiquated and unsatisfactory substitute. As to the matter of accuracy of a contour map, that is another question. It is not to be expected that any large proportion of forest area can be mapped in any one year on a basis of double running the 40s with abney level lines. This work should be reserved for valuable forest areas such as we have in Douglas fir, the redwoods, sugar pine, and some of the western white pine areas to be logged within a relatively few years. By this means utilization costs can be saved to the extent of many, many times the cost of the accurate map work. All progressive logging engineers and lumbermen alike recognize this. For working plan purposes rapid survey methods with the plane table establishing rough contours and locating the timber by blocks of uniform composition and volume per unit of area can be readily done at very low cost by any forester skilled in rough ocular estimating. The essentials of a working plan are calculation of the yield and allocation of the cutting to the proper areas. Accomplishment of these ends cannot be intelligently attained without this minimum of information, although it is by no means necessary to strip survey the entire working plan area.

The violation of proper practice of sustained yield and allocation of cutting have been the greatest factors in bringing the American forests to their present low state of productivity. As a result of lack of sustained yield areas have been stripped of their timber and abandoned in some parts of the country, while in others lack of cutting leaves the timber to decay in the forests instead of being utilized. This was, of course, in considerable measure unavoidable in the past, but industrial development is now so widely spread over the whole area of the United States that it is inexcusable to continue these methods much longer. However, the requirements of sustained yield on any given area will be satisfied reasonably well from the economic standpoint if present cutting is not allowed to exceed a figure which will leave always a sufficient cut in view to insure a reasonable continuance of economic size logging and wood manufacturing industries. If this is done it will always be possible to rebuild the forests to full productivity on any area without excessive cost because the profits from and proper method of continued utilization on the area can be used for gradual improvement of the forest without the necessity of long time compound interest accumulations. Moreover, continuous

operation of wood-using industries within the area saves plant depreciation and results in closer and closer utilization, savings which in themselves will generally be more than sufficient to maintain the forest in producing condition. It follows that sustained yield, at least in a minimum measure, is important at any economic period of forest development which results in any cutting at all.

The principles of proper order of cutting in the stands within any given area are equally important at all periods of economic development. These principles largely determine whether the earnings from the forest will be high or be low. Taking the price as well as volume and quality into consideration, they demand that stands making low earnings be removed first and those making high earnings be retained. The result of such action is to sustain, or even increase, the average earnings of the forest investment. These principles cannot be elaborated further here, and it must suffice to say that they, together with sustained yield, will, if properly applied, conserve the forest investment and do away with the depletion charge. It is doubtful whether any considerable area of American forests in regions where cutting has been active since the civil war, would have failed to make good earnings, even under private ownership if these principles had been properly applied. The biggest fact that foresters appear to have generally failed to grasp is that on account of the rapid price increment taking place for the last 40 to 50 years, and still to continue for many years to come, that we have let half of the most profitable period for undertaking forestry in this country go by already.

REVIEWS

The San Francisco Bay Marine Piling Survey. Third Annual Progress Report. San Francisco Bay Marine Piling Committee. Published by the Committee, Feb. 20, 1923. Executive Office, Ferry Building, San Francisco.

The San Francisco Bay Marine Piling Committee was formed in 1920 to study the work and control of marine borers in San Francisco Bay. Teredo navalis previously appearing sporadically, began in 1917 to assume grave importance and several large marine structures collapsed as a result of its work. This, the third report of the Committee is, like the preceding reports, of greatest practical and scientific interest and usefulness. The report itself covers 55 pages and includes 6 tables, 6 plates, and 2 maps, but with it are bound, as appendices, four reprints of scientific papers bearing on the biology of marine borers. These reprints add 58 pages, 8 plates and 1 map.

The forester is interested in the work of this Committee because of the large amount of wood used in marine structures principally as piling. If marine borers are not held in check there results an unnecessary drain on the forests to furnish piles and timbers for replacements. That this additional demand may be great is evident when it becomes known that one type of borer alone, Teredo navalis, may destroy a pile in a very few months. Teredo, a mollusk, and limnoria, a crustacean, are the most serious pests.

Teredo navalis warrants the greatest and most immediate concern of owners of marine structures because it has suddenly become epidemic in San Francisco Bay, is rapidly increasing in the great harbors of the Atlantic Coast and because its work of destruction is very fast and thorough. Moverover, unlike the limnoria, whose work is quite obvious to the most casual observer, the Teredo works largely unseen and its presence becomes known only through careful examination of exposed parts by trained eyes or becomes tragically evident upon the collapse of an entire costly structure. In the report are presented the findings of biologists and chemists based on studies bearing on the life of teredo which are of first importance in combating the teredo. For example it is learned that contrary to earlier beliefs, teredo does digest

some of the wood removed in boring its gallery. Heretofore it was believed the galleries were made only for a domicile, but laboratory tests demonstrate that the wood in passing through the digestive tract loses 80 per cent of its cellulose and 15 to 56 per cent of its hemicelluloses. This is of importance as suggesting methods of control since "digestion of wood by Teredo produces optimum conditions for the absorption of toxic substances contained in the wood." Important also to the peace of mind of the owner of a marine structure who believes his property is safe because of low salinity or because of sewege in his waters, is the determination that the average lethal salinity for Teredo navalis is 5 parts in 1,000 and that extremely putrid conditions will not inhibit the breeding and activity of this borer. Disturbing to the owner who feels secure because he has replaced wood with concrete is the report that a pholad borer has been found damaging concrete pile casings in Los Angeles harbor. This is not conclusive proof that concrete in general is susceptible of attack, the damage reported being in a material of very poor character, in fact considered by some engineers as not worthy of the designation—concrete. Further observations of the work of pholad borers are therefore of greatest interest and importance. Aside from the possible borer menace, concrete is given much attention in the report. Sixteen pages of the wharf construction section are devoted to specifications for concrete materials, manipulation and construction, in this way seeking to set up standards that will provide concrete structures better able to withstand the injurious effects of conditions peculiar to marine situations. Foresters will be interested also in that part of the report concerning the use of wood preservatives. The service records section of the report presents data from which may be drawn conclusions respecting the use of untreated wooden piles and the efficacy of piles protected with paint-and-batten coating, piles protected with concrete, creosoted wooden piles, and reinforced concrete cylinders placed in open caissons. Where the attack is severe, the report states that untreated piling may last only six to eight months, and in places of less severity from two to four years. Paint and batten coatings may lengthen the life of a pile to from five to eight years if the work is well done. Creosoted Douglas fir piling may be expected to give a life of from 15 to 20 years under present conditions. The report emphasizes that poor preservative treatment of piles or damage after treatment by careless handling, rafting, etcetera, will materially reduce the life of creosoted piling.

Even very small injuries to the creosoted surface permit the ready entrance of teredo and particularly of limnoria. The efficacy of concrete protections of several kinds is likewise reported upon.

In the chemical section are reported observations made on a number of test pieces placed in the bay to determine the value of various creosote fractions; the extent and character of losses of creosote exposed under varying conditions; effect of degree of penetration upon composition of creosote; effect of inorganic inhibitents; effect of chlorine on Teredo; and the protection of wood with various toxic salts. Indications are that creosote penetrates wood in an unaltered condition; that teredo can stand a chlorine concentration of up to one part in 100,000; and that the use of toxic salts is limited because too readily leached, but that certain salts may become so changed by the wood itself as to form a residual product not susceptible to leaching. E. F.

Report of the Division of Forestry of the Board of Agriculture and Forestry, Territory of Hawaii, for the Biennial Period Ending December 31, 1922. By C. S. Judd, Superintendent of Forestry. Reprint from the Report of the Board. Honolulu, Hawaii, 923. Pp. 15-51.

This report from Hawaii is a record of satisfactory progress. The outstanding features are the better protection of the forest reserves that has been secured through fencing and the removal or extermination of wild cattle, the extension of the forest area through planting, and the increased efficiency in administration that has followed a reorganization of the ranger force. As in earlier reports there are several tables of forest reserve areas, lists of trees introduced and planted, and copies of recent laws and regulations.

The forest reserves of Hawaii are unique in that a majority of them must be treated as absolute protection forest. The more important reserves lie on the windward slopes of the high mountains that intercept the moisture laden trade winds. In these sub-tropical rain forests the native vegetation is unable to withstand the inroads of the rank growing foreign grasses and weeds that take advantage of every artificial opening. Even small breaks in the cover tend seriously to affect the run-off in the forest streams that must be protected to feed the irrigation ditches, which in turn make possible the profitable production of the main crop of the islands—sugar cane. Water is the most valuable product of these forests. From them men and cattle must alike be rigorously excluded.

The most important project of the biennium was the making secure of the boundaries of the Hilo Forest Reserve on the Island of Hawaii, a water conserving jungle of 11,750 acres, with an outside boundary approximately 79 miles in length. Fortunately natural barriers could be depended on in large part, but many stretches of wire fence had to be constructed under conditions that rendered the work must difficult of execution. On the four main islands some 60 miles of fence were built or repaired during the two-year period. Considered relatively this figure is significant, for it is comparable to a much larger total expressed in terms of the Continental United States.

Changes of boundary and additions to the existing forest reserves effected during the period brought the total reserve acreage up to 841,015 acres, of which 68 per cent, or 579,936 acres is land belonging to the Territory. The greater part of the privately-owned forest in the reserves is owned or controlled by the sugar plantation companies who are glad to cooperate with the Territorial Government in its protection. For comparison it may be noted that the total land area of the Hawaiian Islands is approximately four million acres. About 20 per cent, then, consists of forest reserves.

The extension of the forest through the planting of non-agricultural land assumes two phases in Hawaii. In former years more stress was put on the afforestation of waste lands on the sugar plantations with rapid growing trees of economic value, like certain of the eucalypts, Grevillea and Casuarina. In the past two years the chief aim has been to fill in openings and to extend the native forest on the watersheds. One of the native trees, Koa (an acacia) takes first place as to numbers planted, but many introduced trees from other sub-tropical and tropical countries have also been planted on the forest reserves. Among these are a number of species of the genus Ficus, Logwood, Benquet Pine, araucaria, Macadamia, and Australian red cedar. Not all of these were planted in forests of the protection class. There is in Hawaii much semi-arid land which also needs attention.

Of particular interest is a 27-acre plantation of *Hydnocarpus anthelmintica,* one of the trees producing chaulmoogra oil, which of late years has assumed high importance in the treatment of leprosy. The seed were secured in Siam by Mr. J. F. Rock, formerly Territorial Botanist of Hawaii, now one of the Botanical Explorers of the Plant Introduction Service of the U. S. Department of Agriculture. These trees are set 20 x 20 feet. It is expected that in time enough oil can be

produced to meet the local need of the Territory in the treatment of this disease.

Measurements of temperate zone trees planted 10 years ago at elevations of from 7 to 9,000 feet on two of the higher mountains showed that the Coulter Pine had done best, with a maximum height of 17 feet and a crop of cones. Incense cedar likewise did well, and also, rather curiously, Pinus strobus. It was to determine whether trees of this type could be made to grow on the mountains of Hawaii that the project was undertaken. The results seem to indicate that afforestation with the species noted might well be seriously considered by the Territory.

C. S. Judd, Superintendent of Forestry, and C. J. Kraebel both took part in 1922 in a course of instruction in forestry at the University of Hawaii, outside of their regular duties, the idea being to make a beginning toward a course to train young men locally for the forest ranger force.

As is customary with the publications of the Hawaiian Board of Agriculture and Forestry, this report is a good piece of press work. It is illustrated by nine excellent full-page illustrations of typical Hawaiian forests.

R. S. H.

The University of Washington Forest Club Quarterly. Volume I, No. 4, 3 illustrations, 60 pages; Volume II, No. 1, 12 illustrations, 68 pages.

In Volume I, No. 4, the editors have made available to the students of forestry legislation the report of the Second Annual Forestry Conference to the Legislature of the State of Washington; Summary of the First Meeting of the Forestry Conference Committee; and the reports of five of the committees of the Conference. This volume should prove to be valuable as a reference on up-to-date legislation in forestry.

India, Alaska, and the State of Washington are the prominent topics of Volume II, No. 1. The article on Alaska is particularly timely as the attention of the public is being focused on that "Treasure Island" of Uncle Sam's. The conclusions on "The Comparative Fire-Resistance of Douglas Fir and Redwood" would be more convincing had the author submitted all the data of the problem. The prospective

tropical forester may well consider "The Problems of a Logging Engineer in British India" and he will be well repaid in reading the article.

D. S. J.

Forestry for Profit. By Theophilus Tunis. New York, G. P. Putnam's Sons, 1923. $3.50.

Is it an impractical dream to advocate the growing and tending of forest crops just as the farmer grows and tends fruit trees? Can the forester afford, for example, to plant his forest trees very widely spaced, cultivate the soil, prune the trees, and then enrich the soil with 800 pounds of lime per acre? The author presents a theoretical argument for such intensive "farm-forestry." His theory certainly runs counter to sound forest economics. Even in Europe under the intensive conditions that exist in state forests, and even with pre-war labor at 50 to 75 cents a day, the author's system would prove too expensive. The capitalized supply bill for fertilizer and the labor bill for planting, cultivation, and for pruning would probably amount to more than the intermediate and final crops. From the silvical standpoint the intensive pruning of forest trees would probably give mediocre results. Hardwoods, for example, if grown in such open stands, would often produce epicormic branches which would require a second pruning.

On the other hand, in the United States at least, it would be interesting for the U. S. Forest Service to institute some experiments in the intensive pruning of conifers in order to give a scientific answer to the problems which Mr. Tunis raises.

About one-half of the book consists of fragmentary quotations from other authors, many of which are far from clear, removed as they are from their context.

T. S. W., Jr.

Insects Attacking Forest and Shade Trees. By H. B. Peirson, Bulletin No. 1, Maine Forest Service, 1923. Pages 56, plates 8.

Mr. Peirson, since September, 1921, Forest Entomologist for the State of Maine, has produced an exceedingly interesting and readable publication, Only three pages are devoted to shade tree insects, the balance of the bulletin dealing with insects which attack forest trees. At the time of Mr. Peirson's appointment practical control for the spruce budworm was, and still is, the principal forest problem needing solution in the State of Maine. It is quite fitting, therefore, that nearly half of this bulletin should be devoted to the consideration of this

insect and its control. Details in regard to the habits of the budworm and the character of the injury caused are given.

Peirson indicates that the spruce budworm has been the primary cause for all the bad insect outbreaks in the spruce and fir forests of the Northeast so far back as records go. While the budworm has been the primary cause for the past outbreaks, as those of 1818 and 1820, often they have been attributed to bark beetles. The bark beetles are merely secondary enemies enabled to become epidemic through the weakening of the trees under budworm attacks. The last attack of the budworm starting in 1910 and extending up to the present time followed a similar course.

The purpose of the Maine Forest Service, in the field too late to prevent this last attack, is the prevention of all future outbreaks. This, Mr. Peirson says, is a perfectly reasonable and possible goal. Briefly, the plan for control now under way in Maine includes the following points:

1. A forest type map will be made for the entire forest area. Already this map is finished for over one-half the forest area. The forest type is recognized as a controlling factor as to where the start of a budworm outbreak will occur and as to the extent of the damage. Such outbreaks start in pure softwood stands containing a large amount of fir.

2. Patrol of the forest areas is provided for. This is secured through the cooperation of the various fire wardens, timber cruisers, foresters, etc., who are continually passing through the Maine woods. The type map indicates the areas which should be visited each year in order to find probable outbreaks.

3. Once located, each outbreak will be controlled in its incipient stage. The entomologist inspects each infested area as located, and if the situation is serious the owner is notified and asked to cut clean the spruce and fir. Such action makes it impossible for the young larva emerging in the spring to find sufficient food. Control operations of this character may return a profit and in any case are estimated to nearly if not quite pay for themselbes.

Peirson states that mixed spruce and hardwood forest with as little admixture of fir as possible should be aimed at in future forest management. This mixture is advised because of the relative immunity

from budworm attack of the softwoods when mixed with or growing under a hardwood cover. He also advised the cutting of all softwoods as soon as they overtop the hardwoods. On areas of pure fir, a short rotation is advised.

Timber killed by the budworm must be utilized immediately if used for lumber. If used for pulp, the fir stays good for about three years, and the spruce from five to seven years. It is stated that the rate of deterioration of budworm killed timber is more rapid on favorable sites where the softwood grew fastest. Operators are urged to take advantage of this point and to salvage material on such sites before cutting the timber on the slower growing areas such as swamps and shallow-soiled uplands.

In discussing bark beetles, Peirson shows that there must exist some primary cause weakening the timber before bark beetles can assume epidemic form. The chief primary cause is the budworm. Other primary causes may be ground fires, scorching the bases of the trees, and accumulations of green slash due to logging operations or to windfall.

The bulletin covers very comprehensively the insects attacking white pine. Peirson says that it is to be expected that the great increase in pure pine stands will result in increased amount of insect damage. He lists the white pine weevil (*Pissodes strobi*) as the most serious enemy of the white pine. Close planting (6 by 6 foot spacing) is the most effective way of preventing serious damage from the white pine weevil. For controlling white grubs in the nursery he mentions the use of arsenic mixed with the soil. More planting of red pine or spruce along with the present plantings of white pine is recommended. These plantings are not to be made in mixed stands but in relatively small areas, pure. Larch insects, hardwood insects, and shade tree insects all receive attention.

The bulletin, while written primarily for land owners in Maine, has application throughout a much wider territory. It is refreshing to find an entomological bulletin free from long descriptions of insects. More bulletins of this character furnishing information of economic value as to forest insects and usable methods for their control are urgently needed.

R. C. H.

Agriculture in Cut-over Redwood Lands. By Warren T. Clarke. Bulletin 350, College of Agriculture, University of California. Pages 19, illustrations 8.

This publication was prepared as the result of investigations by the author of the results of agriculture on cut-over lands in the Coast redwood region of California, during which some time was spent in operating a farm in that locality. It is of interest to foresters because of the conclusion that the redwood forest land after cutting is better suited for the production of a second crop of timber than for agriculture or grazing. A description is given of the several different kinds of soil found within limited areas together with the heavy rainfall in winter and considerable heat in summer.

The difficulty in clearing redwood stump land is brought out and reference made to one area where the cost of complete clearing was $400 per acre and another where all stumps under two feet in diameter were removed at a cost of $150 per acre. The vitality of redwood stumps in producing coppice sprouts and the difficulty of killing the stumps is emphasized by the statement that on one tract under observation redwood stumps treated to ten annual burnings in which the sprouts were cut off and piled around the stumps, then sprouted almost as sturdily as immediately after cutting. A wide range of crops and deciduous fruits can be grown, but transportation and marketing are difficult and owing to the isolation of the farms the conditions of farm social life are not attractive.

The conclusions of the study may be quoted from the preface of the bulletin as follows: The present value of the redwood forests of the State of California and the increasing area of cut-over redwood lands resulting from the logging work that is being done make the future of these cut-over lands a problem of great economic importance to the State. In view of the increasingly insistent demands of our civilization for lumber, it seems that the most natural and advantageous use to which these redwood forests can be put is in the continued production of timber. S. B.

Erosion and Flood Problems in California. By E. N. Munns, Forest Examiner. Report on Senate Concurrent Resolution No. 27 by California State Board of Forestry. Pages 165, illustrations 40, maps 3.

As a result of a resolution passed by the California legislature in 1921 requesting an examination of areas in the State which have been

or are being denuded of timber or other vegetative covering with harmful results to watersheds, the author made a study of the problem during the seasons of 1921 and 1922, under the direction of the State Board of Forestry. The report is published with a joint letter of transmittal to the legislature from the State board recommending fire protection, acquisition of cut-over lands by the State, an equitable system of taxation for growing timber and consideration of tree planting as a means of restocking the small portion of denuded or non-forested lands that will not be reforested through fire protection alone.

The remainder of the report is the work of Mr. Munns and begins with a discussion of the factors influencing stream flow and erosion. The effect of fire is brought out by reference to a study made on the area of a brush fire that occurred in the San Bernadino Mountains in 1914. The water-holding capacity of the soil on the adjoining check area was 58 per cent in 1914 and 1921, whereas that of the soil on the burned area declined to 32 per cent in 1917 and was only 38 per cent in 1921.

The conclusion of the report is that the cover on 2,201,700 acres has been devasted, 399,000 acres completely and the balance partially; devastation being explained as meaning the partial destruction of the stand so that while a cover is present, it is not productive. Fire is given as the principal destructive agent being held responsible for the complete devastation of 208,000 acres and partial destruction of 773,500 acres. Lumbering is placed next with a total of 875,000 acres of which only 90,000 acres is described as completely devasted. The total area of the cut-over forest lands in the State is given in the appendix of the report as 1,800,000 acres. Next in order as agents that have produced devastation come smelter fumes with a total of 195,500 acres, of which 77,500 acres are described as completely, and over-grazing with 23,600 acres completely and 126,100 acres partly devasted.

Five measures are recommended as necessary to prevent further erosion and to control erosion under way. The first is adequate fire protection and suggestions are made for legislation to strengthen fire laws and to require clearing of railroad rights of way and around logging engines, for increased educational work with public, for additional appropriations for fire suppression, for postponement of hazardous areas with special regulations during periods of unusual fire hazard.

A campaign of education is suggested with stockmen to show the disadvantages of over-grazing. It is recommended to prevent further destruction of important cover by smelter fumes that no smelter be

permitted to liberate sufficient gas in its operations to kill vegetation. Legislation is considered essential to give the State Board of Forestry power to regulate destructive cutting and logging practices on privately-owned lands on watersheds. Two possibilities are mentioned relative to the establishment of cover on denuded areas, one that the owner be required to repair the damage, and the other that such areas be acquired by States and municipalities and replanted.

The second part of the report deals particularly with forest lands. In regard to logging pine lands, the conclusion is that in order to keep the forest land continually productive it is necessary to (1) save advance growth in logging, (2) leave seed trees, (3) protect the cut-over area from fire. High lead yarding is considered as undesirable because of heavy destruction to advance growth, and high-speed yarding is condemned if in excess of 500 feet per minute. The suggestion is made with relation to seed trees that in the pure pine stands of the east side that a minimum diameter limit of 20 inches be followed and that elsewhere the limit be 18 inches in cutting on private lands. For fire protection of cut-over areas, the recommendations are clearing along railway tracks, clearing around logging engines, use of spark arresters and oil burners, establishment of some cleared lines through slash if necessary, and maintenance of patrol. Broadcast slash burning is not endorsed and the system of piling and burning brush as practiced on National Forest timber sale areas is question as being too expensive.

These logging requirements are not applicable to the redwood region, as advance reproduction is not considered. It is recommended that burning to clear before logging should take place as soon as possible after cutting in order that the first growth of sprouts may not be killed. The second consideration to obtain the best reproduction is absolute prevention of fire after logging. The suggestion is made that Douglas fir seed trees be left to help fill in blanks, and planting is considered necessary to properly restock many cut-over areas.

The report contains an appendix in which are compiled very complete statistics concerning California forest lands, showing estimated stands of timber, and acreages by counties. The present privately-owned virgin timber is placed at 3,119,249 acres in the pine region and 1,069,192 acres in the redwood region. The present average annual cut-over area includes 40,000 acres in the pine and 10,000 acres in the redwood. The appendix also includes a most complete bibliography of publications relating to erosion, the influence of forests on stream flow and the influence of forests on climatic factors.

S. B.

PERIODICAL LITERATURE

Norway's Forest Experiment Station

The third annual volume of reports of the Norwegian Experiment Station, now under the direction of Erling Eide, contains an article of unusual interest to American foresters on determinations of temperature and seed crops in the Scotch pine forests of northern Norway.

As Swedish scientists have already pointed out, there is a marked delay in germination of Scotch pine seed in northern Norway: many seeds do not germinate the first season, "lying over" in the ground one or more years.

The reason for this seems to be a lack of ripeness of the seed. Just as all trees are not equally exposed to light and warmth, so all cones are not equally exposed, and even the seeds within the same cone are not equally favored.

A summer temperature of 10.5 degrees C. is necessary for proper ripening. Frequently 50 years must pass before the full seed year and the proper ripening temperature coincide. This explains the partial character of natural regeneration—even though the amount of seed produced is ample. And the reverse has been noted.

The cure lies in proper soil conditions which encourage germination of seed. Selection forest seldom secures this and does not admit sufficient light to stimulate delayed germination. Working of the soil is indicated—and a cover crop of birch may be necessary in order to increase the nitrogen content of the soil.

Further studies in the natural regeneration of various forest types are contemplated. A. B. R.

Ueber Temperatur messungen und Samenertrag in den Kiefernwaeldern des noerdlichen Norwegens in 1920. Erling Eide in Communications of the Norwegian Forest Experiment Station, Vol. 3, Christiania, 1923. Pp. 133.

The Makiling Echo

Under this title the Philippine Bureau of Forestry has issued through its Division of Investigation a mimeographed quarterly, which is more ambitious than the usual news letter. The first two issues of the Echo, those for September and December, 1922, are

evidence of this ambition. It is to be regretted that the publication cannot be printed, since the mimeograph is either of poor quality, or else the operator is unskilled. The reading contents are marred by the poor typography.

The editor is to be congratulated upon having prepared a publication which is interesting and full of good material as well. Thus, in the first issue there is a very excellent address by Mr. Fischer on Forest Conservation. In the same issue there is an excellent article on The Purpose and Needs of the Division of Investigation, by its Chief, O. W. Pflueger.

The rest of the issue is made up of notes, technical, alumni, and the like. Forestry educators will be interested in the tabulation of present vocations of forest school graduates, showing that of the graduates of the College at Laguna 64 per cent are in the Bureau of Forestry out of a total of 244 graduates.

The second issue is an improvement on the first and is better systematized. The technical section occupies the place of honor with an article by Mr. Woodwroth on Entomology. This is followed by articles on the Botanic Garden and on reforestation projects.

The wood preservers will be interested in notes by Ranger Nano on The Resistance of American Timbers to the Termites.

This issue contains the usual grist of alumni and bureau notes.

Of special note in this issue is a review of Dr. Rock's Bulletin, U. S. Department of Agriculture, No. 1057, on The Chaulmoogra Tree and Some Related Species. The oil derived from the fruit of these trees is a specific for leprosy and is obviously of greatest interest to the members of the Philippines Bureau of Forestry. Although not strictly a forest product, the harvesting of this valuable oil and the cultivation of these trees which bear the fruit from which this oil is derived is fascinating to read about, especially when it is borne in mind what a long, painful, and hazardous journey was made by the author in his effort to locate and secure authentic material.

The Philippine Bureau of Forestry is to be congratulated upon so forward looking a publication. May all success attend it. A. B. R.

The Makiling Echo. Vol. 1, Nos. 1 and 2, Sept., 1922, pp. 45; Nos. 3 and 4, Dec., 1922, pp. 46. Los Banos, P. I.

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NOTES

New Course at Cornell

The Department of Chemistry at Cornell has decided to inaugurate a course in the chemistry of pulp and paper making, beginning with the spring term of 1924. This course is primarily intended for professional foresters, but other students in the University who are qualified will be admitted. The course will be a two-hour lecture course extending over the customary 16 weeks of the term. Elementary inorganic chemistry and a course in engineering chemistry are prerequisites for the work in pulp and paper. At present this is the only work in forest products given directly in chemistry, but it is likely that the work will be expanded if it proves successful in pulp and paper. Wood distillation is at present touched upon briefly in certain advanced courses in chemistry and wood preservation in the course on engineering chemistry.

Research in Rubber

Harry W. Whitford, professor of tropical forestry at Yale University, has been named by Secretary Hoover to take charge of the federal investigation into possible new sources of rubber supply authorized by the last Congress. He will explore the possibilities of cultivation in the Philippines, South America and other tropical areas not now utilized for the purpose.

A Notable Contribution to Forest Research

Announcement has just been made of the gift of $200,000 as an endowment for experimental research in forestry, this sum to be equally divided between the Yale School of Forestry and the Department of Forestry at Harvard. The gift is anonymous. The donor, it is stated, is deeply interested in the advance of forestry in the Northeast, and especially in New England. The money has been granted in the belief that research and experiment in the field problems of forestry will do more than any other one thing to bring about forestry practice.

SOCIETY AFFAIRS

Annual Meeting of the Society

An invitation is extended to all members of the Society of American Foresters to submit papers on any branch of forestry of a technical or professional character for the program of the annual meeting to be held in either New York or Baltimore, in December, 1923. There are many foresters not often heard from, who, from observation and experience, are in a position to contribute facts or conclusions of value to the profession, but who do not do so for lack of opportunity or invitation. All such are urged to send in papers to the Secretary, W. N. Sparhawk, Forest Service, Washington, D. C., before November 1, 1923.

Papers should not exceed 1,500 words in length. Not over 10 minutes should be consumed in presenting a paper. The choice of articles to be placed on the program will be based on, first, general value to the profession at large; second, originality of material, and third, intention to attend in person.

H. H. Chapman,
Chairman, Committee on Meetings.

John E. Rhodes

It is with deep sorrow that the Journal has to announce the death of Mr. John E. Rhodes, Secretary-Manager of the Southern Pine Association, on June 2, 1923. Mr. Rhodes was an Associate Member of the Society since 1913 and was one of the few men in the industry who thoroughly understood the needs of the industry and at the same time realized the necessity of saving the forests. He worked untiringly to bridge over what at times appeared to be opposing views. The cause of forestry has lost a splendid worker.

Amendments to the Constitution

The recent ballot on proposed amendments to the Constitution of the Society resulted as follows:

Amendment 1—Election of Members and Associate Members by the Sections instead of by the Executive Council—

Number of members qualified to vote.. 414
Number of votes cast..... 177
Necessary to carry (three-fourths).... 133
Against adoption ..... 64 For..... 113 *Lost*

Amendment 2—Change in organization and election of Executive Council—
Number of votes cast..... 175
Necessary to carry..... 132
Against adoption ..... 68 For..... 107 *Lost*

Amendment 3—Correction of wording of Article III, Sections 1 and 2—
Number of votes cast..... 175
Against adoption ..... 2 For..... 173 *Carried*

Amendment 4—Change of wording of Article IV, Section 2—
Number of votes cast..... 179
Against adoption ..... 1 For..... 178 *Carried*

Amendment 5—Change of date for submitting nominations for officers—
Number of votes cast..... 179
Against adoption ..... 1 For..... 178 *Carried*

Amendment 6—Provision for enlarging Committee on Meetings .....*Carried unanimously*

The four amendments which passed are as follows:

3. Amend Article III, Sections 1 and 2, by eliminating the words "Candidates for membership must be recommended for election to the Society by at least three Senior Members or Fellows," in paragraph (1), and inserting in the third line of Section 2, after "In Charge of Admissions," the following: . . . "indorsed by at least three Senior Members or Fellows, and," and also by substituting the words "each candidates" for "all candidates" so that the first sentence of Section 2 will read:

"The name of each candidate for Member, Senior Member, Associate Member, Honorary Member, and Corresponding Member shall be submitted in writing to the Member of the Executive Council designated 'In Charge of Admissions,' indorsed by at least three Senior Members or Fellows, and accompanied by a biographical sketch giving fully the qualifications of the candidate for admission to the designated grade of membership in the Society."

4. Amend Article IV, Section 2, by substituting for the words "first executive meeting of the calendar year," the words "annual meeting of each year," so that the Section will read:

"The officers shall be elected, as hereinafter provided in Article V, Section 3, from the Senior Members and Fellows by letter ballot at the annual meeting of each year, and shall serve one year, or until their successors are elected."

5. Amend Article V, Section 3, by substituting in the third sentence "six (6)" in place of "four (4)," so that the sentence will read:

"Other nominations, if indorsed by at least ten (10) Senior Members or Fellows and presented to the Secretary in writing at least six (6) weeks before the annual meeting, shall also be submitted to the membership on the official ballot."

6. Amend Article V, Section 4, adding the following sentence:

"The chairman of the Committee may appoint such sub-committees, from any grade of membership, as he shall deem necessary to assist in arranging for meetings."

Membership

The following have been elected Senior Members of the Society, effective May 5: Bernard E. Leete and Carl C. Perry. The following have been elected Members and Associate Members: Members—John R. Berry, Thomas H. Crawshaw, Solon J. Hyde, DeForest A. Matteson, Erwin H. Rengstorff, Harris A. Reynolds, John P. VanOrsdel. Associate Members—F. B. Hutchins, Joseph G. Lewis, Solon Williams.

Carl B. Neal has resigned as Member of the Society, effective January 1, 1923. At their own request, C. R. Clark (Member) and C. R. Garvey (Senior Member) have been dropped in accordance with Article X of the Constitution. William C. Hodge, Jr., has resigned as Senior Member. Roy S. Rogers, elected to Membership January 1, 1923, has declined to accept the election.

Committee on Admissions

In accordance with the Constitution, President Hosmer has appointed R. C. Bryant as the Member of the Executive Council in Charge of Admissions.

Committee on Meetings

H. H. Chapman has been appointed as Chairman of the Committee on Meetings for the current year.

Ohio Valley Section

The organization meeting of the Ohio Valley Section, held at Ann Arbor, Mich., January 20, was followed by afternoon and evening meetings on the same day, attended by about 35 members and guests. Talks were given by Marcus Schaaf on the Michigan State Forests, by Prof. C. O. Sauer on forestry and land economics, by Edmund Secrest on the State forestry work in Ohio, by B. N. Prentice and C. C. Deam on forestry problems in Indiana, by L. J. Young on the soil and economic survey in Michigan, and by Professor Roth. On the following day, the members visited the experimental forests belonging to the University Department of Forestry. The next meeting is to be held in Ohio in the fall.

Pennsylvania Section

At the annual meeting held in Harrisburg on February 23, the following officers were reelected: Chairman, Gifford Pinchot; Vice-Chairman, John Foley; Secretary, J. A. Ferguson, State College.

Central Rocky Mountain Section

The Central Rocky Mountain Section has held the following meetings this year:

January 19. Talk by C. G. Bates on the 1923 District Investigative Program. Attendance 11.

February 10. Business meeting. Attendance 30.

February 15. Paper by Grazing Examiner Jesse M. Mann, on "Grazing Reconnaissance Methods as Followed in District Two." Attendance 24.

March 15. Paper by G. M. Hunter on "The Effect of Density on Later Growth of Lodgepole Pine." Attendance 13.

Northern Rocky Mountain Section

M. H. Wolff has been appointed to the vacancy on the Section's Executive Committee caused by the transfer of E. F. White to Madison.

Washington Section

At a meeting held on March 8, the Washington Section elected the following officers to serve for the remainder of the year: Chairman, J. F. Preston; Secretary-Teasurer, W. W. Ashe; Member of Execu-

tive Committee, E. T. Clark. A Committee on Meetings was appointed, consisting of J. P. Kinney, C. R. Tillotson, and W. R. Mattoon, and a Program Committee consisting of Raphael Zon, H. A. Smith, D. P. Tierney, and W. W. Ashe.

Meetings have been held as follows:

March 8. "The Clarke Forestry Bill," by E. A. Sherman, Associate Forester, and "Loblolly Pine," with slides and motion pictures, by J. A. Cope, Assistant State Forester, Maryland.

March 22. "Control of Forest Insects—How It Is Being Worked Out in the West," by F. P. Keen, Bureau of Plant Industry. "Botanical Nomenclature," discussion by G. B. Sudworth, W. W. Ashe, W. A. Dayton, A. S. Hitchcock, T. S. Palmer, and others.

April 26. "The Federal Income Tax and Forestry," by R. C. Hall, Bureau of Internal Revenue." "State Forest Taxation," by L. S. Murphy, Forest Service.

May 3. "The Standardization of Lumber," by Wilson Compton, Secretary-Manager, National Lumber Manufacturers' Association. "Standardization" (illustrated), by W. A. Durgin, Chief of the Division of Simplified Practice, Department of Commerce.

North Pacific Section

The North Pacific Section has elected the following officers for 1923: Chairman, D. T. Mason; Secretary-Treasurer, A. J. Jaenicke; Member Executive Committee, B. P. Kirkland. The Committee on Program consists of J. F. Kummel, W. H. Gibbons, and J. D. Warner, and the Committee on Membership of A. W. Cooper, J. D. Guthrie, and L. C. Merriam.

Madison Section

The Madison Section arranged the following program for the winter season, 1922-1923:

(1) Friday, December 8. General Meeting. Public invited.
Illustrated Lecture, "A Trip Through Australia," by Mr. Tiemann.

(2) Wednesday, January 31. Forestry Topics.
Current Events, Miss Gerry, Mr. White.
Discussion of Laboratory Activities: Glues, Mr. Jones; Paints, Mr. Dunlap; Chemical Research, Dr. Hawley.

Report of Boston Meeting of S. A. F., December 29 and 30, Mr. Tiemann.

Discussion.

(3) Thursday, February 15. General Meeting. Public invited.

Illustrated Lecture, "Impressions of Alaska and the Yukon, Their Extent and Character, How They Are Being Treated, and Possibilities of Their Development," by Mr. Markwardt.

(4) Wednesday, March 7. Forestry Topics and Laboratory.

Discussion of Laboratory Activities: Present Situation of Pulp and Paper Work, Dr. Rue; Review of Accomplishments Since the War in Design and Structural Uses of Wood, Mr. Wilson; Progress of Technical Kiln Drying in the United States and in Foreign Countries, Messrs. Thelen and Tiemann.

Debate, "Resolved, That the Government Should Control Privately Owned Forests."

Or, "Foresters Should Practice What They Preach and Own Their Own Forests."

(5) Thursday, March 29. Wisconsin Topics. Public invited.

"The Present Forestry Situation in Wisconsin." Illustrated talk by C. L. Harrington.

"Recreational Use of the National Forests and Wisconsin Forests." Illustrated talk by E. V. Jotter.

(6) About April 18. Forestry Topics.

Talks by visiting foresters from the Districts. Discussion.

(7) Wednesday, May 9. General Meeting. Public Invited.

"Some of the Most Remarkable Trees in the World." Illustrated: North and South America, Mr. Koehler; New Zealand and Australia, Mr. Tiemann.

(8) Thursday, May 31. Final Meeting. Forestry Topics.

Current Forestry Events.

Discussion of Laboratory Activities.

"The Use of Trees in Landscape Gardening." Illustrated. Professor Aust.

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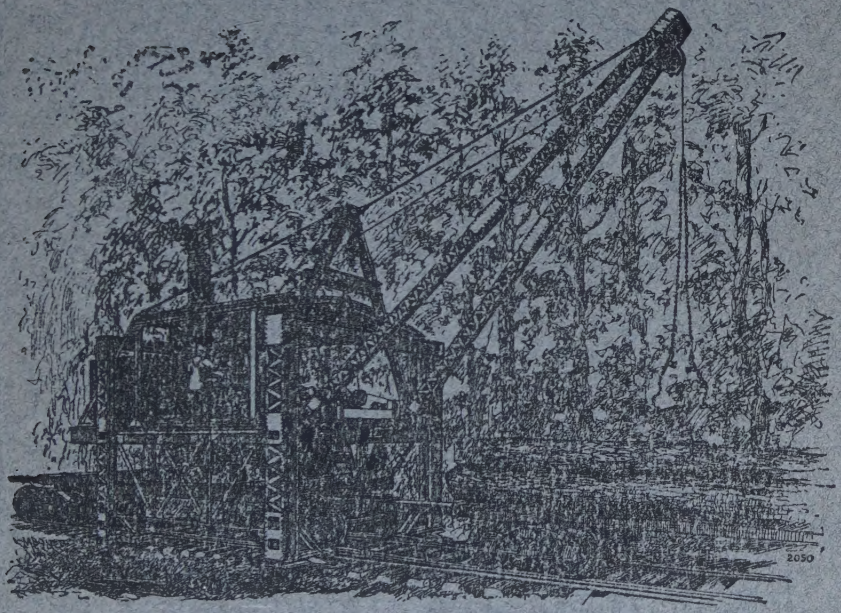

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